ASSET LIABILITY MANAGEMENT MODEL: THE CASE OF SELECTED ISLAMIC BANKS IN MALAYSIA

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2017

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THESIS SUBMITTED IN FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

INSTITUTE OF GRADUATE STUDIES
UNIVERSITY OF MALAYA
KUALA LUMPUR

2017

UNIVERSITI MALAYA

ORIGINAL LITERARY WORK DECLARATION

Name of Candidate: Chong Hui Ling

Registration/Matric No: HHB110004

Name of Degree: Doctor of Philosophy

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Asset Liability Management Model: The Case of Selected Islamic Banks in Malaysia

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ABSTRACT

There have been questions recently about the ability of the Islamic bank as the main competitor of the conventional bank in preventing future banking crisis from recurring. If they are to fulfil this objective, Islamic banks must have robust treasury management mechanisms in place, since effective treasury functions like asset and liability management are crucial to avoiding the risks of insolvency and bank collapse.

This study proposes an approach using a multi-objective penalty cost function, which allows the management of assets and liabilities of a bank in a realistic environment that has been simulated and proven to enhance the performance of the system. Specifically, this research has been conducted with the core objective to develop a customised programming model for multi-purpose optimisation using this penalty cost method that ties together divergent objectives unique to Islamic banks. This method produces a solution that minimises the gap between these objectives, targets and actual performance. The study takes Bank Islam Malaysia Berhad‟s (BIMB) financial data to validate the model. The multi-faceted objectives consist of the bank‟s expected returns and risks tolerance with constraints (also known as restraining functions to reflect the limitations placed on the Islamic bank‟s operating requirements), established using computational mathematics and algorithms with the aid of the MATLAB programming software. The research innovates by adding the wealth objectives of the three Islamic shareholding classes: *musharakah* partnership, *mudaraba* investment, and shareholder capital. Five years‟ financial data from 2009 to 2013 were sampled from secondary sources like Thompson Reuters‟ DataStream, the bank‟s financial statements, and other sources such as market yields from Islamic Interbank Money Market website.

The output from the model is a set of solutions for funds allocation that minimises the asset liability performance gap for BIMB. The study contributes by combining computational tractability with religious oriented asset liability management. This multiple objective (henceforth is used interchangeably with multi-objective) optimisation – something which would have been difficult to implement in the days when information technology was not as advanced as it is today, is implemented in this study. The multi-objectives are subject to both binding and non-binding constraints to reflect the actual Islamic banking environment. The second outcome of this research is BIMB‟s optimal portfolio as a benchmark model for the academic industry for future contributions to the body of knowledge in this field.

Algorithms established for the optimisation processes are documented for the study. Interviews with treasury committees of BIMB bank and feedback from the MATLAB system were taken to validate and determine the model‟s efficiency. This research contributes to the growing literature of innovation in asset liability management techniques through computational mathematics and financial modeling. It adds value to the operational and strategic decision makers of Islamic banks. It also provides pointers to future research directions to academicians and researchers from this field.

ABSTRAK

Sejak kebelakangan ini timbul persoalan sama ada bank Islam yang merupakan pesaing utama kepada bank konvensional berupaya untuk membantu mencegah krisis perbankan daripada berulang pada masa yang akan datang. Jika objektif ini hendak dipenuhi, bank Islam mestilah mempunyai makenisme perbendaharaan yang menyeluruh kerana fungsi perbendaharaan yang menyeluruh amat penting bagi mengelak risiko masalah kewangan dan keruntuhan bank tersebut.

Kajian ini mencadangkan pendekatan „kos penalti‟ pelbagai matlamat yang membolehkan pengurusan aset serta tangungan melalui sistem seumpama keaadan realistik dengan simulasi yang telahpun dibuktikan keberkesanannya dalam membantu merealisasikan matlamat fungsi perbankan Islam. Secara dasarnya, matlamat utama kajian ini adalah untuk mengembangkan model pengurusan aset dan tanggungan yang merangkumi pelbagai matlamat bagi pencapaian prestasi perbankan optimum khas untuk bank Islam. Proses ini menggunakan pendekatan fungsi „kos penalti‟ yang merangkumi lima matlamat pelbagai dalam pengurusan aset dan tanggungan bank Islam. Kaedah ini mencadangkan satu set penyelesaian yang bakal mengurangkan jurang antara objektif, sasaran dan prestasi sebenar dalam pengurusan aset dan tangungan. Kajian ini menggunakan data kewangan Bank Islam Malaysia Berhad (BIMB) untuk memastikan keberkesanan model ini. Matlamat yang pelbagai ini merangkumi objektif pulangan serta toleransi bank Islam terhadap risiko perbankan bersama fungsi kekangan dalam bentuk matematik (ianya juga dikenal sebagai fungsi kekangan yang menentukan sistem operasi sebenar perbankan Islam) dengan rumusan matematik dan algoritma berdasarkan perisian proses MATLAB. Kajian ini menginovasi model pengurusan aset dan tanggungan konvensional dengan memuatkan objektif kewangan yang menitikberatkan matlamat pengayaan akaun pelaburan khas

(*mushrakah*), pemegang akaun pelaburan am (*mudaraba*) dan para pelabur ekuiti iaitu pemegang dana saham. Data kewangan daripada sumber sekunder seperti pangkalan Data *Thompson Reuters*‟, laporan kewangan BIMB, sumber lain seperti laman web kaunter kumpulan pasaran bank Islam jangka pendek bagi data kadar faedah untuk BIMB dari tempoh antara tahun 2009 hingga 2013.

Hasil kajian dengan model ini merupakan satu kombinasi aset dan tanggungan bagi pengurusan dana pada tahap yang dapat mengurangkan jurang prestasi ramalan dengan yang sebenar untuk BIMB. Kajian ini juga memberi sumbangan kepada hasil literator yang lepas, dari segi penggabungan penjejakan taksiran melalui nilai keagamaan dalam pengurusan aset dan tanggungan. Sehubungan ini, istilah „pelbagai matlamat‟ dan „pelbagai-objektif‟ diggunakan secara silih berganti – satu pendekatan yang rumit pada masa lepas tetapi dimudahkan oleh kemajuan teknologi komputer pada masa kini. Model pelbagai-objektif ini memuatkan kekangan berkewajipan serta tidak-berkewajipan bagi mencerminkan keadaan sebenar operasi perbankan Islam di Malaysia. Hasil kajiaan yang kedua iaitu satu kombinasi aset dan tanggungan yang optimum bagi BIMB, dijadikan sebagai sumber penanda asas untuk menyokong perkembangan industri akademia di masa depan.

Algoritma yang dihasilkan untuk proses pengoptimuman aset dan tanggungan telah didokumentasikan untuk kajian ini. Langkah-langkah bagi memastikan keberkesanan model ini dilaksanakan dengan menemu duga wakil-wakil jawatankuasa perbendaharaan BIMB untuk mengenalpasti kegunaan model ini di samping mengesahkan penyelesaian aplikasi perisian MATLAB. Kesimpulannya, hasil kajian ini dapat menyumbang kepada sumber ilmu penyelidikan dari segi inovasi bagi kaedah pengurusan aset dan tanggungan melalui rumusan matematik serta teknik pengaturan konsep kewangan. Hasil kajian ini berfaedah kepada proses perangkaan strategi peingkat operasional dan strategik BIMB. Ianya juga memberi hala tuju yang dapat dijadikan sebagai wawasan dalam penyelidikan kepada akademik serta industi di masa yang akan datang.

ACKNOWLEDGEMENT

The success of this study‟s completion and compilation was not without tears and constant hard work, persistence and long-term determination. Also, this work would not have been accomplished with the contribution of all distinguished individuals who were involved either directly or indirectly in many ways of support; financially, motivation, and care. I thank my supervisor, Associate Professor Dr. Rusnah Muhamad for her motivation, insights and guidance in structuring my thoughts especially during the initial phase of my dissertation write up. She gave me countless opportunities in getting myself equipped with all necessary research knowledge needed for this study. With her strong religious faith, I learnt lots to the need to be humble no matter where I go.

I am also taking this opportunity to thank my co-adviser, Associate Professor Ravindran Ramasamy from Universiti Tun Abdul Razak, who has constantly guided me with his knowledge and expertise during the process of financial modeling mathematically and financial engineering. I am always thankful and indebted to a special lady, since my birth and it would be my gratitude to say this out loud, "*Thank you MOM, you‟re always there for me whenever I needed you and you talked to me so softly and tenderly, listening with empathy when I wanted a shoulder to cry on, and you* ***are*** *always there. THANK YOU MOM"*! Thank you Christiano and Hannan Lu my lovely boys, for being patient when mummy was busy.

To all special individuals whom I have yet named here, I thank you for your presence during the completion of any part of this dissertation.

Above All, I thank The GOD Almighty for all wonderful blessings and the lovely people around me!

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SYMBOLS

x_i	x value of variable i
x_j	x value of variable j
y_i	y value of variable i
y_j	y value of variable j
a_{ij}	Technological coefficient of x_j in goal i
b_i	Target value of goal i
C_{mj}	Consumption coefficient of x_j in constraint m
r_m	Available amount of resource m
d_i^+	Over achievement of the target for goal i
d_i^-	Underachievement of the target for goal i
P_i	Priority weight of the deviation variables of goal i

ABBREVIATIONS

AAOIFI	Accounting and Auditing Organisation for Islamic Financial Institutions
AFB	Asian Finance Bank Berhad
AFS	available-for-sale
AITAB	*Ijara Muntahiah Bittamleek* or *Ijara Thumma al-Bai"*
ALCO	Asset and Liability Committee
ALM	Asset and Liability Management
BFR	Base Financing Rate
BIMB	Bank Islam Malaysia Berhad
BNM	Bank Negara Malaysia (Central Bank of Malaysia)
CA 1965	Companies Act 1965
CBA	Central Bank of Malaysia (Amendment) Act

CMSA	Capital Market and Securities Act 2007
DAFIA	Development Financial Institution Act 2002
EL	Eligible Liabilities
ETP	Economic Transformation Plan
FSA	Financial Services Act 2013
GIA	General Investment Account
GIIs	Government Investment Issues
GST	Goods & Services Tax
HFT	held-for-trading
HQLA	high-quality liquid assets
HTM	held-to-maturity
IAH	Investment Account Holder
IAS 39.3	International Accounting Standards 39.3
IASB	International Accounting Standards Board
IBS	Islamic Banking Scheme
IDB	Inter-American Development Bank
IFIS	Islamic Financial Institutions and Services
IFSA 2013	Islamic Financial Services Act 2013
IFSB	Islamic Financial Services Board
IFI	Islamic Financial Institutions
IIMM	Islamic Inter-Bank Money Market
INI	Islamic Negotiable Instruments
INID	Islamic Negotiable Instruments of Deposit
KFH	Kuwait Finance House
KLIBOR	Kuala Lumpur Interbank Offering Rate
KLSE	Kuala Lumpur Stock Exchange
KLSEB	Kuala Lumpur Stock Exchange Berhad

LCR	Liquidity Coverage Ratio
LIBOR	London Interbank Lending Rate
MFRS 9	Malaysian Financial Reporting Standards 9
MIB	MayBIMBic Bank Berhad
MPs	Members of Parliament
MYR	Malaysian Ringgit
NIDC	Negotiable Islamic Debt Certificate
OPR	Overnight Policy Rate
OREO	Other Real Estate Owned
PIDM	Malaysia Deposit Insurance Corporation
RAM	Rating Agency Malaysia
RAM	Rating Agency Malaysia Holdings Berhad
RM	*Ringgit Malaysia* (Malaysia Currency)
RSS	Regulated Short Selling
RWA	Risk Weight Assets
SAC	*Shari'ah* Advisory Council
SCA	Stochastic data Collection Apparatus
SEMS	Stock Exchange of Malaysia and Singapore
SIA	Special Investment Account
SNA 1993	1993 System of National Accounts
SPI	*Skim Perbankan Islam (*Islamic Banking Scheme)
SPTF	*Skim Perbankan Tanpa Faedah* (Interest-free Banking Scheme)
SRA	Statutory Reserve Accounts
SRR	Statutory Reserve Requirement
YDPA	*Yang di-Pertuan Agong* (The King)

NOMENCLATURE AND TERMINOLOGY OF ARABIC TERMS

Akhlaq	Moral and Ethics
al-Hibah	Contract of gift
al-Wadi‟ah	Contract of deposits
al-Wakalah	Contract of agency
Amanah	Trust
Aqidah	Faith and belief
Bai bithaman ajil	A credit sale of goods on a deferred payment basis. At the request of its customer, the financial institution purchases an existing contract to buy certain assets on a deferred payment schedule and then sells the goods back to customer at an agreed upon price, including a profit.
Bai‟ al-inah	This contract operates concurrently with the sale and buy-back scheme.
Fiqh	Muslim jurisprudence: it covers all aspects of life - religion, political, social or economic. In addition to religious observances (prayer, fasting, *zakat* and pilgrimage) it covers family law, inheritance, social obligations, commerce, criminal law, constitutional law and international relations, including war. The whole corpus of *fiqh* is based primarily on the *Qur‟an* and the Sunnah and secondarily on *ijma‟* (consensus) and *ijtihad* (effort to derive juristic opinions).
Gharar	Excessive risk taking or uncertainty
Hadith	Refers to deeds, sayings and endorsements of the Prophet Muhammad (*p.b.u.h.*) that his companion captured and narrated. The Hadith represents the religious reference to the purpose and course of living among the Muslims after the Holy Qur‟an.
Haram	Anything prohibited by the *Shari‟ah*
Hibah	Gift
Ijara	A leasing arrangement whereby one party purchases an asset and leases it to another party. Lease purchase is a contracted transaction, whereby the owner of a specific capital rents the assets to an end user for a known period of time. There are two forms of leasing: *ijara* (true leasing) with no option of ownership for the lease; and *ijara wa iktina* (financial lease; in Malaysia,

this is known as *ijara thumma al-bai'*) where the lessee has the option of eventual ownership.

Ijma	Consensus of the jurists on any issue of *fiqh* after the death of the Prophet Muhammad (peace be upon Him).
Maysir	Speculation
Muamalat	Affairs of the world, including civil and commercial transactions.
Mudaraba	An agreement between two or more persons whereby one or more of them provide finance, while the others provide entrepreneurship and management to carry on any business venture whether trade, industry or service, with the objective of earning profits. Any profits accrued are shared by them in an agreed proportion. The loss is borne only by the financiers in proportion to their share in total capital.
Mudarib	Agent
Murabahah	In this contract seller make known the cost and profit of a transaction. A sale will then take place after a mutually agreed profit rate is reached.
Musharakah	Partnership between two or more persons whereby all of them have a share in finance as well as entrepreneurship and management, though not necessarily equally. The profit is distributed among the partners in pre-agreed ratios, while the loss is borne by each partner strictly in proportion to respective capital contribution.
Qiyas	Argument by analogy in legal and theological areas.
Qard ul"hassan	Benevolent loan which obliges the borrower to repay the principal sum borrowed on maturity. The borrower has the right to decide whether to reward the lender for the loan by paying any amount above the amount of the loan.
Qur'an	The Holy Book of the Muslims consisting of the revelations made by God to the Prophet Muhammad (peace be upon Him).
Rab'ul mal	Equity capital contributor
Riba	Literally means increase or addition and refers to the „premium" that must be paid by the borrower to the lender along with the principal amount as a condition for the loan or an extension in its maturity. It is thus equivalent to interest.

Shari'ah	Refers to the divine guidance as given by the *Qur'an* and the *Sunnah* and embodies all aspects of the Islamic faith, including beliefs and practices.
Sukuk	Credit financial instruments with longer maturity and structure similar to conventional bonds but is *Shari'ah* compliant.
Sunnah	After the *Qur'an*, the *Sunnah* is the most important source of Islamic faith and refers essentially to the Prophet Muhammad (peace be upon Him) example as indicated by his practices of faith. The only way to know the *Sunnah* is through the collection of *Hadith*.
Takaful	It is a type of Islamic religious instrument, mutually guaranteeing and supporting, with shared responsibilities between groups of people covered by this insurance. It is an alternative insurance product to the conventional non-*Shari'ah* compliant insurance.
Tawheed	Represents the indivisible Oneness between God and His believers, the Muslims. It regards a crucial concept among the Muslims that God is The One and Only God for worship.
Tawarruq	This is a product with opposite features to *murabahah* because it acquires cash through trade activities by buying the item on credit, arranged on deferred payment scheme before selling it immediately to a third party, at a discounted price.
Uqud al-ishtirak	Profit-sharing contract
Zakat	Religious obligation on the Muslim to pay a predetermined percentage of the value of their annual savings, commodities, or properties to the Islamic state, mainly for the benefit of the poor and the needy.

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CHAPTER 1: RESEARCH OVERVIEW AND OBJECTIVES

1.1 Introduction

Asset and liability management is the core function of the treasury department. The role played by this function is parallel to the role played by human"s heart that determines the core survival of that human. As the heart of a bank, the treasury department ensures that funds are managed and channelled to different components and various departments as efficiently and effectively as possible (Ahmed, Iqbal and Khan, 1983, Ariff and Iqbal, 2008; Gruening and Iqbal, 2008 and Iqbal and Mirakhor, 2011). Without a sound asset and liability management, a bank could suffer liquidity problem (Abdul-Rahman, 1999; Charnes and Thore, 1966) and ultimately be forced to close down as a result of being non-productive. This is clearly something to avoid in an economy since, as an entity entrusted with managing the public"s wealth, a bank collapse could seriously affect the flow of funds in an economy (Adebola, Wan Yusoff and Bahalan, 2011; Charnes and Thore, 1966).

There have been some famous or infamous examples of bank failures throughout the decades, mainly as the result of poor management by the treasury function, and specifically asset and liability management. The list of treasury catastrophes includes the Microfinance Bank of Africa (Abayomi, 2011). Hokkaido Takushoku Bank (Knufken, 2009), Buffalo Savings Bank (went into bankruptcy), and, most recently in January 2014, the alarming near liquidation of HSBC Bank (reported by BBC News). This largest British bank was reported to be technically insolvent, again as a result of having a dysfunctional treasury system. In listing these banks, it is noteworthy that they are all conventional interest-based financial institutions. Being in a monetarily driven business, these conventional banks were and are in most cases run by managers with conflicting self-interests – which could have been the cause of their treasury management failures.

Following several waves of global financial crises, the world in recent years has begun to raise questions and to look for alternative ways of running monetary and financial systems in order to avoid further repetitions. Among the possible solutions are Islamic financial institutions, with their reputation for being „socially responsible" economic entities (Archer and Karim, 2006; Williams and Nguyen, 2005). However, as the Islamic finance industry is still in its early stages, there is a lot of work to be done to place it on a proper and sound risk management (Gruening and Iqbal, 2008) basis and ensure that it follows best practices in treasury management. Moreover, there are very few clear methodologies in the literature on asset and liability management.

Given the increasing hope and trust being placed in Islamic financial institutions in many Muslim and non-Muslim countries, this research proposes an improvised method in financial modeling for an asset liability management problem guided by the set of optimisation algorithms designed to be compliant with *Shari'ah* or Islamic principles for a resilient Islamic bank"s asset liability management. Its main research objective is to produce a simulated financial model for asset liability management in an Islamic bank. Section 1.7 of this chapter sets out the structure of this research.

1.2 Background to the Study

Below are brief discussions about the outstanding differences between the Islamic and conventional bank in Malaysia. The Islamic bank compared to its conventional competitor is operating based on religious ethics for the betterment of the economy and society at large. Ethics should be the key component to the operational sustainability of a business.

Islamic Finance and Culture: Economic Decisions and its Impact

The issue of reporting ethics gained huge prominence in the wake of the Enron and Arthur Anderson scandal in the United States in October 2001 (Bloomberg BusinessWeek, January 28, 2002). Following that disaster, public interest in how a company achieves and reports its financial position grew enormously, and government agencies and authorities begun to channel increasing efforts into setting more robust and stringent principles of reporting. At the heart of these is the company balance sheet, which is rightly seen as a vital indicator of how funds are being managed. Carefully planned treasury and especially asset and liability management became the order of the day (Ahmed, Iqbal and Khan, 1983; Gruening and Iqbal, 2008).

In parallel with this, recent years have seen a strong growth in interest in Islamic banking, as a new approach to banking based on religious principles. With its moral and religious aspects, Islamic banking is perceived as a possible means of helping to prevent future financial crises.

Asset liability management[1] is the core function of the treasury department of any financial institution. Being in a monetary driven business that manages the public‟s funds, a financial institution like a bank also faces more and more complex risks than other types of businesses (Gruening and Iqbal, 2008; Iqbal and Mirakhor, 2011). On top of this, religious financial institutions like Islamic banks face

[1] Gruening and Iqbal (2008, p. 146) defined theoretically assets and liability management is the organisation of balance sheet, long term planning, execution and control process that influence size, mix, time period, risk associated with interest rate uncertainty, and liquidity associated with banks‟ assets. In nutshell, the core of object of organisation of assets and liabilities is to enhance the earning and value of firm by management of particular risk linked with the resources of the firm.

some unique constraints and risks above and beyond the common financial risks associated with conventional interest-bearing banks (Iqbal and Mirakhor, 2011). Islamic banks operate in contexts that are heavily guided by Islamic law, known as *Shari‟ah*[2], which gives rise to slightly different paradigms of financial, operational, governance and other problems in asset and liability management. As economic entities entrusted to manage the public‟s funds consistent with Islamic principles, Islamic banking institutions require more complex quantitative tools for their asset liability management.

In the past, challenges in asset and liability management caused banks to take strategic decisions with an eye on the evolving regulatory requirements, leading to unresponsive and inflexible asset liability management based on the rigid balance sheet structure (Gruening and Iqbal, 2008, p. 278*),* which makes change difficult. Managements have to work hard to achieve effective yet flexible asset and liability management through well-tailored tools and strategies. Moreover, risk management should not be a standalone objective, but rather should involve most if not all divisions of a bank. Inevitably, conflicts will arise between different objectives: for example, between the pursuit of maximum returns and the desire to minimise costs and/or risks. The challenge is how to balance these.

One way of resolving such conflicts between multiple objectives in asset liability management is the use of the type of optimisation model suitable to the environment of the institution‟s (i.e. bank, hospital, insurance institution, pension fund institution and so on) operating structure (Mulvey, Romanyuk, 2010; Rosenbaum and Shetty, 1997). Financial optimisation models involve mathematical analysis using sophisticated tools from the mathematical sciences. Today‟s sophisticated and powerful computing capabilities allow much better and more accurate modeling of the asset and

[2] It is the basic requirement of *Shari‟ah* that all Islamic Financial Institution must follow the guidance of *Shari‟ah* called Islamic rules on transactions (*Fiqh al-Muamalat*) (Ibrahim and Hamid, 2007, p. 21). The rules of *Shari‟ah* are source of guidance for Muslims that lead them to submission towards Allah and His Messenger the Prophet Mohammed (Kettel, 2011, p. 13).

liability environment than was traditionally possible, including the creation of simulations that can greatly help to determine the most effective asset and liability strategies for a company to pursue. According to Chaturvedi (2010, p. 32), modeling empowers us to question and explore the linkage between the affiliated people of one system. He said modeling can be defined as method of abstraction of a real system. It also gives an abstract structure relating the actual system and function as model for the real system. It therefore allows experiments to be performed in a computational environment which may not be possible in the past – before the advancement of the computational era, to test potential outcomes of the real contexts in event of changes in factors (variables) affecting the operational environment of the Islamic bank‟s asset liability decisions (Chaturvedi, 2010, p. 32). It would not be practical to conduct an analysis with object to examine the impact of increasing rate of market on the net income of IFIs by increasing or decreasing market rates in the real environment. But with a realistic simulation, it is possible to model accurately the actual effects of such a change.

In line with the above, this study formulates a set of mathematics function as a representation to the multi-objective asset liability optimisation model for all the elements that could have impact on the effectiveness of an Islamic bank in Malaysia. The aim is to study these components together, not in isolation, to promote better asset liability or also known as the balance sheet management in Islamic banks through a mathematical model (represented by the set of mathematic functions) tested within the MATLAB R2009b software environment (Chong and Zak, 2013; Chaturvedi, 2010). In particular, this research proposes a set of asset liability allocation weights (the composition of funds or capital to be channelled to each item of asset and liability), that effectively optimises the outcome of multiple objectives in asset and liability management, and which produces an optimal asset allocation that takes account of the constraints imposed by the Islamic banking legislative and regulatory environment.

This chapter covers briefly the structure of the thesis. The next section (Section 1.3) briefly considers the problems faced by Islamic banks in asset and liability management. Section 1.4 details the Research Objectives to be accomplished by this research. It also lists all Research Questions systematically to guide the design and flow of the research processes (see Section 1.5) executed by the study. These research processes follow the philosophical foundation detailed in Chapter 3. Section 1.6 highlights its limitations, delimitations, motivations and significance. Finally, the concluding section of this chapter (Section 1.7) outlines the organisation of the other chapters of this thesis.

The Treasury Function of an Islamic Bank: Asset Liability Management

The work of asset liability management was initiated back in 1970s. Its significance emerged when interest rate became highly volatile causing huge mismatches between the rate sensitive assets and liabilities and making risks management difficult (Kusy and Ziemba, 1986).

Essentially, the asset liability management involves the combinations of several processes from operational risk management to strategic planning. It is not confined to providing solutions that will help mitigate or hedge risks from the mixtures of these assets and liabilities. Its focus is more specifically on the long-run objectives which can only be met with success through optimising the performance of the bank‟s balance sheet. This process should also consider the complexities of the asset liability structures and how these elements interact in returns maximisation. It is a daunting task to calibrate the firm wide tools and techniques incorporating and managing other risk factors within the wider risk spectrum other than only satisfying regulatory and capital requirements during this process. More crucial is the different assessment of the risk return trade-offs (Abedifar, Molyneux and Tarazi, 2013; Jobst, 2007) in the asset liability management strategies to ensure that it is customised to the specific operating structure of the Islamic banks. Islamic bank operates in a slightly differing structure compared to its conventional interest-based competitors. These differences arise because of the *Shari'ah* complying contractual nature governing all transactions of the Islamic banks (Jobst, 2007).

In Malaysia, Islamic banking transactions started to gain awareness when Bank Islam Malaysia Berhad (BIMB) began offering this religious compliant services back in 1983 (Adebola *et al*., 2011, p. 400). Now with Islamic and conventional banks functioning in parallel (ISRA, 2012, p. 128; Adebola *et al*., 2011, p. 22) a dual system is operated in Malaysia. These banks are similar in most operational aspects, but with the difference that Islamic banks are subject to religious objectives and commitments based on the guidance of *Shari'ah,* generally called Islamic principles on transactions (Ibrahim and Hamid, 2007, p. 21). Further discussions on *Fiqh al-Muamalat* can be found in Chapter 2 on "History, Operating Background and Environment of Islamic Banks in Malaysia".

1.3 Problem Statement

The problems of the asset liability management stems from the balance sheet structure (the characteristics of the balance sheet) of different industries (Beck, Demirgüç-Kunt and Merrouche, 2013, Kosmidou and Zopounidis, 2001). The mixture of different assets and liabilities within the balance sheet determines the risk exposures and returns of the bank. In general, regardless of the type of banks, either conventional or Islamic, the common problem faced by the banks due to their nature of business that is receiving deposits and providing financing, exposes the banks to maturity gaps problems (deviation arising from the term to maturities between the assets and liabilities). These gaps lead to the interest rate and liquidity risks which should be considered and managed within a simulated environment with the aid of financial modeling. This gave motivations to the study to develop a customised asset liability multi-objective optimisation considering strategic and operational needs of BIMB.

Adding to this, the unique contractual nature of Islamic banks gives rise to specific additional risks. These are typically treasury risks like liquidity, rate of return, equity investment, market and hedging risks (Gruening and Iqbal, 2008). Gruening and Iqbal (2008) argued that Islamic banks do not face interest rate risks but rather market risk, albeit market risk is similar to interest rate risk. Market risk arises because Islamic banks do not have a direct market index as a reference for pricing their products. Most banks refer to the London Interbank Lending Rate (LIBOR), while in Malaysia Islamic banks rely on the Kuala Lumpur Interbank Offering Rate (KLIBOR) as a benchmark. As per date, in 2017, Malaysia has updated the following references for six hundred and seventy-six *Shari'ah* compliant securities and launched three indices as securities performance benchmark in year 2007 (Lean and Parsva, 2012, p. 1274): (1) FTSE Bursa Malaysia *Hijrah Shari'ah* Index, (2) FTSE Bursa Malaysia *Shari'ah* Index, and (3) FTSE small Cap *Shari'ah* Index. Although so, based on the research objectives as well as data availability when data was collected for the model"s validation, it was almost impossible for the incorporation of new data into the mathematics laboratory programming system in MATLAB R2012b. This data collection and model validation have also made mathematical consideration for Basel III capital adequacy compliance sophisticated and almost impossible (Putts, 2012). Therefore, the thesis has allocated more write-ups on Basel II instead of Basel III with slight briefing on Basel III requirements for future researches.

With reference to the balance sheet for asset liability management, other risks involved within the thesis‟ notion are such as the mark-up rate risk, foreign exchange risk, profit rate risk and equity investment risk; are discussed together alongside the mainstream risks faced by both conventional and Islamic banks.

The asset and liability management model in this research is structured to identify the right mix of assets and liabilities, taking into account these various market rate scenarios, with the aim to enhance the yield of Islamic banks at maximum. The model also allows for asset and liability mismatch management in Islamic banks which meets the relevant legislative liquidity requirements for the purposes of liquidity risk management. The Islamic Finance Information Service (IFIS) defines liquidity risk as the risk arising from the potential losses facing Islamic financial institutions when they are not able to raise or increase sufficient funds to meet their obligations, or to increase their assets, without unacceptable costs or losses (IFIS, 2005, p. 19). A common liquidity management problem is a bank‟s ability to provide sufficient funds when there is a larger than expected volume of withdrawals by depositors on demand. This problem is a particular risk in Islamic banks because, as explained earlier, depositors to *mudaraba* contracts earn no contractual returns but instead need to bear a share of any losses. Hence, Islamic banks need to set aside sufficient funds to repay current account holders or depositors on demand. The IFIS Principle 5.2 of liquidity risk management (discussed in detail in Chapter 3) requires Islamic banks to have a mechanism in place to ensure that they have sufficient recourse to *Shari‟ah* compliant funds to mitigate such risks. As noted above, the asset liability management model proposed in this research includes a specific liquidity requirement to cater for this risk.

Keeping abreast with all the above issues alongside current literatures analyses (to be detailed in Chapter 2), we are motivated to develop a model for an asset liability management based on the unique constraints (limitations or boundaries reflecting operating and strategic requirements; regulatory and pragmatically industrial, faced by the Islamic banks in their asset and liability management). This process requires careful studies on the various governing statutes, legislative codes or sections, mandatory guidelines available online, materials from the central bank[3], financial data available online (for missing data) and Thomson Reuters‟ DataStream for money market yields, Rating Agency Malaysia (RAM) Holdings for analyses on reports on strategic and operational strategies of BIMB‟s asset liability management style. All the inputs above are used for the model‟s development.

The insights for the above methodology was driven by similar studies categorised as follow:

(1) Studies adopting financial ratios (see for example, Bidabad and Alllahyarifard, 2008; Htay, 2010; Johnes, 2009; Khan and Mirakhor, 1990; Masruki *et al*., 2011; Olson and Zoubi, 2008; Said, 2011; Samad and Hassan, 1999; and Siddiqui, 2008);

(2) Data envelopment analysis for asset liability management efficiency comparisons by Bader *et al*. (2008), Fadzlan (2006), Johnes *et al*. (2012), Isik *et al*. (2005), Shah *et al.* (2012), Said (2012), and Sun, Hassan, Hassan, and Ramadilli (2014), and Yudistira (2003).

(3) The Meta-Frontier Analysis (MFA) by Johnes *et al*. (2012);

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[3] The researcher of this work obtained and studied the available references related to asset liability management guidelines such as Bank Negara‟s market, liquidity and credit risk management guidelines for Islamic banks from the Central Bank‟s library at Sasana Kijang, Kuala Lumpur, Malaysia.

(4) Dynamic and static panels by Bader *et al*. (2008);

(5) The Rosse-Panzar model used by Weill (2011);

(6) Relationship studies on technical efficiency of the Gulf Corporation Council (GCC) Islamic banks‟ and its relative impact on stock market performance by Srairi *et al.* (2015); and,

(7) CAMEL rating components for credit risk rating developed by Altman and Saunders (1997) was used to analyse the management‟s competencies between the different structures of Islamic banks.

The detail analysis on the previous studies related to the seven methodologies above is presented in APPENDIX C.

With brief observations above and the gap analyses tabulated in Section 2.10 (pp. 115-116) and the brief summary of these analyses are tabulated in APPENDIX C. With these findings, we are motivated that currently there are not much efforts or specific work dedicated to develop a model mathematically for the Islamic bank‟s asset liability technical management. This model suggests funds allocation ratios (for assets) and value propositions, which is also in the form of financial ratios to be held for each liability and equity items recommended based on programming language inputted as commands (or algorithms) for computation purposes. These ratios are also known as „weights‟ in finance. Hence, the motivation of this research aimed at finding the best optimum assets, liabilities and equities mix through computational mathematics with multi-objective optimisation model for the Islamic banks with BIMB as the model‟s validation. To achieve this main objective, the research has to be based on the existing baseline asset liability management models used by the conventional banks. Bear in mind that these models should be modified and customised to suit *Shari'ah* compliant needs and specific asset liability strategies of BIMB.

The following are common models used by the conventional interest-based banks. They are fundamentals to the developments of specific models that are summarised in Appendix C and detailed discussions are in Section 2.10. Foundational studies akin to this objective are as follow[4]: Pyle (1971) used a static model that allows the bank to choose the asset and liability model that it wants to keep throughout a given time period (in Kusy and Ziemba, 1986, p. 356). They and Cariño *et al.* (1999), created successful optimisation models, but made no clear attempt to address the overall issue of asset-liability management in an Islamic bank. Drummond (2001) later commented in the New York Financial Times that, despite the increase in the number of products and services offered by Islamic banks (especially through windows of the conventional banks); there was still a lack of professional management of a balanced portfolio (of assets and/or assets and liabilities) in such banks. An earlier work by Bidabad and Allahyarifard (2008) attempting to model Islamic Bank asset liability management based on the regression technique did incorporate various asset and liabilities ratios and include the maximisation of economic value as an added function. Their paper tackles this knowledge gap which then opens insights of other research of this field to bring in emerging ideas in Islamic asset liability management modeling. Still, there is less attention from papers published in top journals. Entailing this, a gap in this field is evident. It serves as the motivation to the methodology and design embraced by this thesis.

[4] Refer to Grebeck and Rachev (2005) and Tokat and Rachev (2003) for reviews on stochastic programming methods in the asset and liability management context, Chambers and Charnes (1961) and Sodhi (2005) for linear programming methods, and Kosmidou and Zopounidis (2001) for static models.

In short, this study seeks to bridge the knowledge gap[5] by promoting a multi-objective optimisation model customised to the strategic and operational asset liability management environment of BIMB, taken as the case to validate this model and for the development of a prototype for algorithms that are flexible for replication to other Islamic banks in Malaysia. This research contributes to the body of knowledge to academic and industrial researchers in the area of Islamic banking whilst spurring interest to future works.

1.4 Objectives of the Study

Review of the extant literature suggests that, since the beginning of the classical portfolio theory, there has been limited research especially in the area of Islamic Finance to model the asset liability management problems for the Islamic banking institutions[6]. This thesis aims to fill that gap, by constructing an asset liability management model using the optimisation theory. The model is customised for an Islamic bank in Malaysia, BIMB – taken to validate the model. In order to have a holistic asset liability management for the Islamic banks, the optimisation model should incorporate all significant risks that could affect the bank adversely, thereby jeopardising its performance and sustainability. This process requires the treasurer to incorporate both systematic and non-systematic risks that are unique to Islamic banks (discussed in Section 2.6.2). Beyond this, the bank should also manage the funds of this portfolio of assets and liabilities to generate equitable and fair returns to its capital contributors (equity and debt providers). Hence, it is the duty of the Islamic bank fund manager to strike a balance between risk-return management while meeting religious compliances under *Shari'ah* (Dahl, Meeraus and Zenios, 1993).

[5] See more analyses in Section 1.6 (pp. 21-23) and Section 2.10 (pp. 115-116).

[6] A summary of the gap analysis is included in Appendix C.

This thesis has established three main objectives to achieve the purpose above. However, the ultimate objective for all these processes is to maximise the wealth of its shareholders. But this begs the question: „Whose wealth should the Islamic bank maximise?‟ The fundamentals of financial management tell us that an organisation should work towards the long-term benefit of its shareholders. However, there are three different shareholding structures in an Islamic bank: the *mudaraba* capital contributor, the *musharakah* partners, and traditional shareholders. All of these parties contribute to an Islamic bank‟s equity. In order to narrow our research focus, we will look at only the two basic types of equity capital, based on the rules of central bank, Bank Negara Malaysia, namely: (1) *mudaraba* depositors of an Islamic bank General Investment Account (GIA)[7]; and (2) shareholders[8]. Under the first of these, a *mudaraba* contract, the depositors (*Rab'ul mal*) provide funds to the business through deposits and the Islamic bank (as agent or *Mudarib*) performs fiduciary responsibilities by utilising the funds efficiently within the confines of *Shari'ah* principles. A *Musharakah* partnership, on the other hand, allows both parties – investor and Islamic bank – to undertake risks associated with banking operations, such as in a joint venture. It may also involve partnerships where no capital is required (e.g. under a *Shirkah al-Amal* arrangement). Under such contracts, *Musharakah* partners share the profits and risks from the banking business, with profits distributed between the partners according to a predetermined ratio. As for traditional shareholders, they provide equity capital and have voting rights.

[7] According to the Bank Negara Malaysia guidelines for „Recognition and Measurement of Profit Sharing Investment Account (PSIA) as Risk Absorbent‟, para.1.2, Islamic banking institutions are given full discretion in managing and using all funds allocated to the General Investment Account (GIA). Funds within a Specific Investment Account (SIA) (also known as a „restricted investment account‟) are on the other hand managed according to the provisions within the agreement between the SIA account holders and the Islamic banking institutions. This unique characteristic applies only in the Malaysian Islamic banking environment.

[8] If we included capital from both *mudaraba* investment and *musharakah* partnership in the Specific Investment Account (SIA), this would complicate the asset and liability management model (which is not the objective of this research). Furthermore, including only *mudaraba* contracts allows profits and risks to be shared proportionately. It is this element which allows the central bank to consider capital under GIA as risk absorbent (para. 1.9). All stipulations above are made on the basis of the „Guidelines on the Recognition and Measurement of Profit Sharing Investment Account (PSIA) as Risk Absorbent‟ issued by Bank Negara. In addition to the above, *musharakah* or *mudaraba* funds and other deposit funds under an SIA in Islamic banking institutions are being managed separately (BNM, 2015; para. 1.9).

The above are the main differences between the two types of equity capital contributors mentioned. Their respective features can perhaps be pictured more clearly by understanding the extent of the rights they confer to a bank"s profits. Traditional shareholders cannot demand profit distributions, whereas *Mudaraba* investors will receive their share of profit based on the pre-agreed ratio when the bank makes profit (El-Gamal, 2006; Iqbal and Mirakhor, 2011).

From the above, it is clear that an Islamic bank too needs to seek to maximise the wealth of its GIA account holders, failure to do so shows that the personal interests and goals of managers surpass the interests of shareholders and equity capital providers. In the Islamic finance context, the equity providers include parties to *mudaraba* and *musharakah* contracts. A prolonged conflict of interest if ignored could jeopardize the bank"s long-term growth. This could essentially lead to substantial losses arising from ethical issues such as financial statement fabrication (Beasley, 1996). See for example the case of Enron and World.com scandals. The scandals are typically one of the largest financial scandals in the 20th century (Bloomberg, January 28, 2002). It shows clearly how unethical behaviour and moral hazard can ultimately lead to financial disaster in an organisation. When, on the other hand, managers have the objective of shareholder wealth maximisation, this helps to focus their efforts and resources on the betterment of these shareholders - which is more likely to lead to long-term sustainability and value growth in the organisation. To capture these elements, the asset and liability management model in this research builds in the goal of shareholder wealth maximisation along with the model"s other functions and the constraints that the management must adhere to in meeting this goal. The first objective of this study is, accordingly, to formulate an objective function that maximises the value of the company through economic added value (a common measure of company performance).

The second objective is to construct a range of constraint functions derived from decision variables affecting asset liability decisions in an Islamic bank. These include sector-specific constraints reflecting emerging market scenarios, the banking environment in general, and specificities relevant to Islamic banking in Malaysia. They also include risks faced by Islamic banks in asset liability management. In summary, these risks are market risk, liquidity risk and operational risk.

The third objective of this thesis is to determine the best asset liability combination for an optimum balance sheet management. The study takes BIMB"s balance sheet as a case study for benchmark to other Islamic banks in Malaysia. This model can then be modified to suit the operational and strategic needs of these Islamic banks. More importantly, the model addresses flexibility needs of replication for future improvements by researchers of this field. The summary of research objectives of this thesis is listed below;

Research Objective (1):

To establish an asset liability management model through multi-objective optimisation which reflects an Islamic bank"s actual operating context and unique Islamic banking features in Malaysia. It should also be geared to the wealth maximisation of the different shareholdings of the selected Islamic Bank (BIMB).

Research Objective (2):

To document all the mathematics algorithms (under MATLAB R2012b"s programming environment) for the asset and liability management optimisation model using BIMB as the model"s prototype and validation.

Research Objective (3):

To identify an efficient asset, liability and equity composition itemised on the balance sheet of BIMB. BIMB is taken as prototype to validate the model. The model is flexible to be customised to suit the unique operational and strategic needs of other Islamic banks in Malaysia.

Based on the above objectives, the following research questions are established to direct the process of this research.

1) What are the baseline classical and contemporary literatures supporting the multi-objective asset liability optimisation modeling for the Islamic bank in Malaysia?
2) What would be the design or structure of the modeling stages and algorithms for the multi-objective asset liability management optimisation model for the Islamic bank in Malaysia?
3) What are the decision making contexts or factors affecting the strategic and operational plans of a Malaysian Islamic bank multi-objective asset liability optimisation process?
4) What are the processes and optimisation methodologies proven effective in the conceptualisation of the asset liability style and management sciences for an Islamic bank in Malaysia?
5) What is the tailored multi-objective asset liability optimisation model for the non-interest based *Shari'ah* complying Islamic bank in Malaysia?
6) What is the ideal set of optimum asset liability mix for BIMB using the multi-objective optimisation model?

In order to answer the research questions above, Section 1.5 elaborates the design and stages as well as methodologies established for this research. Figure 1.1 below illustrates the connections and relationships between the six (6) research questions and its main objectives.

Research Objective (1):
To establish an asset liability management model through multi-objective optimisation which reflects an Islamic bank‟s actual operating context and unique Islamic banking features in Malaysia. It should also be geared to the wealth maximisation of the different shareholdings of the selected Islamic Bank (BIMB).

RQ3
What are the decision making contexts or factors affecting the strategic and operational plans of a Malaysian Islamic bank multi-objective asset liability optimisation process?

RQ5
What is the tailored multi-objective asset liability optimisation model for the non-interest based *Shari'ah* complying Islamic bank in Malaysia?

RQ4
What are the processes and optimisation methodologies proven effective in the conceptualisation of the asset liability style and management sciences for an Islamic bank in Malaysia?

Research Objective (2):
To document all the mathematics *algorithms* (under MATLAB R2012b‟s programming environment) for the asset and liability management optimisation model using BIMB as the model‟s prototype and validation.

RQ2
What would be the design or structure of the modeling stages and algorithms for the multi-objective asset liability management optimisation model for the Islamic bank in Malaysia?

RQ1
What are the baseline classical and contemporary literatures supporting the multi-objective asset liability optimisation modeling for the Islamic bank in Malaysia?

Research Objective (3):
To identify an efficient asset, liability and equity composition itemised on the balance sheet of BIMB. BIMB is taken as prototype to validate the model. The model is flexible to be customised to suit the unique operational and strategic needs of other Islamic banks in Malaysia.

RQ6
What is the ideal set of optimum asset liability mix for BIMB using the multi-objective optimisation model?

Figure 1.1: Research Objectives and Questions for a Clear Illustration of its Linkage to Research Solutions

1.5 Research Process

The research begins with financial data collection from BIMB‟s financial statements (year 2009 till 2013) and other secondary source of databases like the Thompson Reuter‟s DataStream, the Islamic Interbank Money Market web page and Rating Agency Malaysia‟s reports for an overview of BIMB‟s asset liability management strategic and operational performances. Ratio analysis is conducted to provide insights on asset liability historical performance management. These insights are used to generate the averaged numerical targets for BIMB‟s short and long run performance targets. During this process, specific ratio reflecting BIMB‟s asset liability management performances are gathered to facilitate the computational mathematics process – a process that requires the construction of mathematic representations mirroring the optimisation of asset liability management for BIMB. This process is based on Chong and Zak (2013) and Leader and Leader (2004).

While performing the above numerical analysis and scientific computation, the objective function for optimisation is formulated with reference to Chong and Zak (2013) and Leader and Leader (2004). This function is customised to suit BIMB‟s strategic and operating environment. BIMB‟s asset liability strategy is scrutinised by analysing the financial information and reports gathered earlier. Analysis from this process is used for constraint functions development. These constraints usually reflect the minimum or maximum resource (assets) allocation and operational cost management. Hence, the constraints will contain elements of BIMB‟s performance target based on year-on-year plans. At the same time, data filtration is performed to prepare the inputs for MATLAB R2009b.

Once these functions are established and that data filtration process is complete, financial data from year 2012 and 2013 is inputted as the sample period to validate the model. The model validation process follows the convergence criteria covered in Chong and Zak (2013). The optimisation process requires the system to search for the point or configuration where the performance gap satisfaction between all different or multiple objectives is at minimum (Chong and Zak, 2013, p. 447). This process is also known as the best-fit curve search process. At the end of this process, a set of asset liability combination which gives this minimum performance gap is obtained. This is known as the set which generates the optimal solution for BIMB"s asset liability management. The ratio for this optimum performance is documented at the end of the optimisation process. Figure 1.2 below illustrates this process in the form of commands (algorithms) that is used as guideline for stages executed to achieve the research objectives in Section 1.4 (page 13).

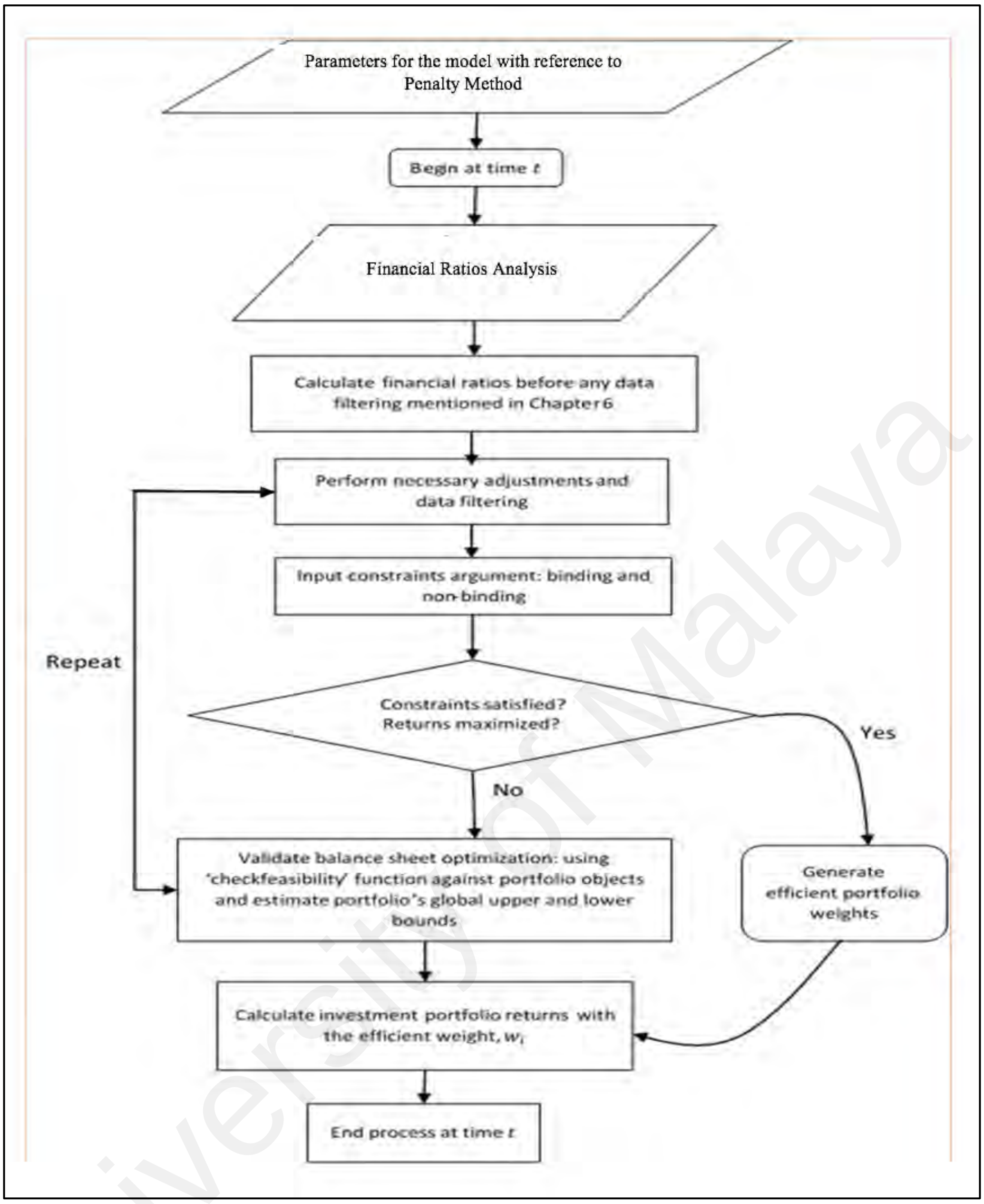


Figure 1.2: An Overview of the Research Process

1.6 Motivation for and Contribution of Research

Over the past since the development of the financial portfolio selection model by Markowitz (1952), continuous revolutions on the way portfolio of assets and liabilities are manage based on different models have been based on modern financial theory (Aouni, Colapinto, and La Torre, 2014, p. 536). Markowitz‟s (1952) model optimises simultaneously two conflicting criteria. They are the portfolio returns and risk associated to financial losses of that portfolio. In order to achieve the best portfolio performance, the treasurer (or portfolio manager) must decide between all available trade-offs. The achievement of the best outcome of this process depends on the manager"s experience, preferences, judgement and intuition (Aouni, Colapinto and La Torre, 2014). According to Markowitz (1952), an optimised outcome can only be achieved when diversification of risk (variance) components is attained by balancing overall risks and returns of all the asset classes contained in that portfolio. Thereon with Markowitz"s (1952, 1959) portfolio management concept, theoretical foundations of this subject has seen increased publications attributable to areas concerning multiple criteria in the optimisation process (Colapinto, La Torre and Aouni, 2017). The models above are based on selection formulations for operational research which are published in highly referred journals such as the *Operations Research, Journal of the Operational Research Society, Annals of Operations Research, Asia-Pacific Journal of Operational Research, European Journal of Operational Research,* and *Mathematics of Operations Research.*

The concept of portfolio selection process continued to expand in the area of operational management sciences. There are various developments in quantitative techniques like stochastic dominance, multi-faceted utility models, multiple criteria and multi-objective programming, neural networks, discriminant analysis, heuristic models, and optimisation models (Elton, Gruber and Rentzler, 1987 and Zopounidis and Doumpos, 2013). Zopounidis and Doumpos (2013) wrote a comprehensive synthesis paper to summarise researches in this area with emphasis given to the applications of multi-criteria decisions in financial management problems. They featured the contributions of the goal programming or multi-objective operational research in portfolio management.

Although studies in operational research for asset liability portfolio management are common[9], limited coverage were devoted to algorithm presentation, general applicability to engineering design of asset liability management portfolio for Islamic banks. Even though there are studies in this area for Islamic banks, these studies are mostly bounded to adopt models that have been pre-developed to assess the quality of the asset liability management decisions. This thesis is motivated to establish a model that caters to specific engineering needs for Islamic banks in Malaysia by taking BIMB to validate the model once it is established.

This *Shari"ah* compliant asset liability optimisation model also captures features like compliance checks to ensure that the balance sheet portfolio hold only assets and liabilities allowable by Islam. This feature ensures that the performance of the Islamic bank"s assets and liabilities is derived only from *Shari"ah* compliant financial instruments. No transaction should arise from non-*Shari"ah* compliant activities. More specifically, the multi-objective asset liability management model makes sure that the *Shari"ah* requirements have to be fulfilled by the bank. This is done through placing specific *Shari"ah* constraints formulated for the model as criteria for an optimal asset liability management which will then determine the bank"s asset liability mix (composition or allocation).

The art of engineering religious specific features into algorithms and computational mathematics gave this study a different angle of contribution to the literature in terms of innovative modern financial management for a portfolio with multiple differing objectives.

[9] See APPENDIX C, page 330 for a comprehensive view of the literatures in portfolio optimisation models for asset liability management.

1.7 Organisation of Chapters

This thesis is comprised of five chapters organised as follow:

CHAPTER ONE: RESEARCH OVERVIEW AND OBJECTIVES

This chapter provides a summarised view of the research. It explains the background and the scope of this study, the research process, justifications and motivations for this research and an overall organisation of the chapters of the thesis. The summary of the overall presentation of the chapters‟ contents, objectives and concise objectives met by each chapter is presented in APPENDIX D on page 336.

CHAPTER TWO: LITERATURE REVIEW

Chapter Two synthesises and amalgamates all concepts related to Islamic finance, the origination of this ideology, a brief introduction on Islamic banking and finance industry in Malaysia, Islamic banking governance in this country and discussions on the importance of the treasury role and function. Specific regulatory requirements especially funds allocation for the Islamic bank‟s capital and reserves were noted in this chapter. These details are used in Chapter Three to refer to the formulation of the multi-objective asset liability management optimisation function. Review on foundational mathematic models is included in this section. Discussions on the specific Islamic bank balance sheet structure and problems arising from this unique structure were included followed by gap analysis[10] and the platform for the model‟s development.

[10] Refer to Section 2.10 and thesummary of the analyses that are tablated in APPENDIX C.

CHAPTER THREE: METHODOLOGY AND METHODS

Chapter Three details research design and philosophies determining the epistemological domains of this study. This research design follows strictly a systematic discussion on the emergence of baseline models in logical precepts to support a comprehensive understanding on computational mathematics and financial modeling. A considerable part of this chapter is devoted to components determining the crucial elements in financial modeling. Inputs used to establish these components are specified in the section on "*Sample Data*" (Section 3.3) of this chapter. All components of financial modeling are explained comprehensively. Algorithm related to this process is documented with assumptions enabling parsimony for the computational stage of the optimisation process. Steps taken to validate the model were discussed in this chapter. In summary, Chapter Three envelops all methodological elements in financial modeling, computational mathematics and data analysis for insights on BIMB‟s asset liability management style strategically and operationally.

CHAPTER FOUR: THE MODEL'S IMPLEMENTATION, RESULTS AND ANALYSIS

Chapter Four presents the results from the analyses of BIMB‟s liquidity, solvency and credit positions as well as the bank‟s 2012 and 2013 performances. These outputs are used to facilitate the financial modeling process to model the bank‟s operational and strategic asset liability management styles[11]. This chapter provides results comparisons (i.e. profitability, liquidity and total asset growth) obtained using current (actual) and the model‟s proposed balance sheet asset allocation. Results of ratio analyses based on these set of allocation (the actual and proposed using the model) is presented in this

[11] See Chapter Three, Section 3.9 on "*Formulation of The Asset Liability Management Model".*

chapter. Generally, Chapter Four presents all analyses and comparisons of outcomes generated from the actual environment and the model with discussions and detailed explanations related to these variances (the actual and simulated results). Detailed discussions and explanations are done with justifications to outcomes that were obtained from announcements, news and statements from BIMB"s independent stakeholders like the press media, Ratings Agency Malaysia – an independent rating agency, and BIMB"s 2012 and 2013 annual reports. In short, this chapter concerns all outcomes of the implementation of the asset liability management model.

CHAPTER FIVE: DISCUSSIONS, IMPLICATIONS, CONCLUSIONS AND RECOMMENDATIONS FOR FUTURE RESEARCH

Chapter Five discusses the implications of major findings of this research. It covers all essential attributes of the asset liability model established for this research. It also provides an overview of the attainment of the research objectives of this study. It compares the results obtained with previous studies in similar fields. Assumptions established for the model are scrutinised in order to provide insights for future model replications and improvements. Chapter 5 continues with limitations from the research and recommendations for replications to improve the asset liability optimisation model in future. It links key findings of the research and suggestions to potential improvements of the Malaysian Islamic bank asset liability management optimisation model. Having a robust asset liability management tool like the balance sheet optimisation system is crucial as banks need cash to fund a loan and the source of fund reported by the central bank (Bank Negara, 2015) should no longer derive only from deposits (Sidhu, 2017, August 14). The latest funding rules for banks since the new liquidity indicator ratio with reference to net stable funding ratio (NSFR), with a revised full-fledged implementation period in Malaysia starting 2019 could lead to higher funding costs, lower margins and higher lending rates. This issue is non-reflective on the financing books of Islamic banks because these banks do not have the concept of net interest margin (Sidhu, 2017, August 14). As a consequence, there will be a slight distortion in the problem experienced by the Islamic bank in liquidity and treasury management compared to conventional bank. The findings of this study implies that there is a profound need for a customised balance sheet management model to reflect and account for specific risk-return trade-offs in Islamic bank. Finally, this chapter proposed several paths future researches can pursue to account for the ongoing evolution in financial technology (fintech) in Malaysia through the incorporation of artificial intelligence and neural network innovations in the banking systems (Jayaseelan, 2017, May 28). This chapter concludes with a brief research summary and research objectives performance.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

This chapter provides an introduction to the operational structure and the treasury functions, specifically asset liability management and the division responsible for this role. It includes various areas of the operations of Islamic banks, their general and religious roles and responsibilities, as well as the workings of the bank"s main division responsible for compliance and functionality. The chapter begins with a brief discussion on the roles and functions of the Islamic bank"s Asset and Liability Management Committee (ALCO) – (See Section 2.2); Section 2.3 gives an overview of the financial markets and systems in Malaysia; Section 2.4 leads the discussion on Islamic banking structure and the industry"s governance in Malaysia. This sub-section briefs the readers the connection between the requirements of these governing bodies and the design of the methodological flow of the multi-objective optimisation model and mathematics formulations in Section 2.7.

2.2 Treasury Function: The Role of Asset and Liability Management Committee (ALCO)

The performance of the treasury division is very much affected by its efficiency in cash flow management. To attain this, it is important that all risks are captured and considered in the process of the asset liability management. An asset liability management regards the management of the funds allocation and values of each item on both on- and off-balance sheets. This objective is often affected by the uncertainty revolving around the changes in the market, economic swings, statutory and regulatory requirements, consumer confidence and loyalty for the bank, and so on. To enhance this performance, the efficiency of ALCO, enterprise risk management concepts proposed by the Committees of Sponsoring Organisations of the Treadway Commission can be considered (Moeller, 2007). It discusses core areas of uncertainties (also viewed as risks) that concerned all industries. Due to its importance, Section 2.6.2 is dedicated to the different types of risks (common to conventional and Islamic banks and risks that are customised to the Islamic operating environment) faced by Islamic banks. Moreover, Amstrong, Fleury and Steve (August 10, 2015) and Basel III emphasised the importance of identifying and managing all potentially significant risks through capital buffers for market, credit and liquidity risks that could harm the bank and its continuity. Understanding the structures causing these risks, as well as their possible effects on Islamic bank operations and continuity, is also crucial. It is important too to manage these risks effectively, because good risk management protects the bank from unforeseen or unmanaged risks that could be seriously damaging to the bank. For risks that cannot be managed and controlled fully, the bank should set aside sufficient buffers. For all these reasons, risk identification is a key task for risk managers – one of whom is the bank‟s treasurer (Armstrong, Fleury and Steve, August 10, 2015).

Though, these discussions are kept brief because the main objective of this thesis is to provide a solution to the multiple objectives in asset liability management to the ALCO (in a set of documented mathematics rules – algorithms). The discussion will move forth with brief coverage on the returns of the Islamic bank, hitherto in this case, BIMB. The subsection of BIMB‟s returns will be structured to include the bank‟s investment objectives so that the formulation of the multi-objective optimisation model will embrace the investment objectives of this bank.

In this process[12], differing objectives of the bank (BIMB) will be scrutinised and analysed carefully by considering different periods of the bank‟s

[12] Refer to the brief research process in Section 1.5 and the details in Chapter 3.

historical operating timelines (from 2009 to 2013). Changes in the strategic and operational directions of BIMB‟s asset liability management strategies will be observed with the assistance of financial statement analysis (through ratio analysis). The thesis has observed with care the specific timeline for data sampling to consider various factors such as BIMB‟s recapitalisation[13] in October 2006[14] and the changes in the bank‟s financial reporting periods (i.e. from June in to December 2013). The interim data was taken for the calculations of average yearly values of assets and liabilities from 2009 to 2013. To avoid programming complexities, this study proposes an asset liability management model focusing on the strategic and tactical levels; and, if strategic concerns come into play, a medium-term analysis can be carried out on an annual basis (Belouafi, 1993).

The chapter further covers the regulatory and legislative environment for the administration and operation of Islamic banks in Malaysia. Understanding the common statutes and codes of governance limiting the activities of Islamic banks is important, since these can affect the risk and return profile of the banks.

The remaining parts of this chapter present an overview of the organisation and structure of banking and financial markets in Malaysia, of the legislative systems governing the operations of the Islamic banking industry, and of an Islamic bank‟s internal supervision, treasury function and Assets and Liabilities Management Committee (ALCO) unique problems and risks inherent in Islamic bank asset liability decisions (Section 2.6), mathematical foundations for optimisation processes and methods of financial modeling and the concluding section of this chapter.

[13] Recapitalisation is a term in finance refers to the changes in the financial structure of a company. This will usually cause changes in the company‟s long-term financing structure depending on how the market perceives the direction where the company is heading in its sustainable future (Srairi, Kouki and Harrathi, 2015).
[14] Williams and Nguyen (2005) found that financial liberalisation (or changes in the capital structure) of a bank will have an impact on the bank‟s performance.

Besides managing general operating risks that are general to both Islamic and conventional banks, the model covers specific risks that could arise due to Malaysia‟s particular political and economic environment. One of the model‟s particular features is its ability to cater for both risk - return management that involves cost and profit functions (the multi-objectivity feature). In the past, such an approach would have been virtually impossible due to the lack of adequate supporting technological knowledge and tools. Nowadays, on the other hand, we can find a vast array of commercialised financial engineering software in the market. Other than the costs of these liabilities, the research includes economic costs that accounting figures might ignore, like the cost of default due to unforeseen withdrawals volumes (AFP, 2015, June 29). Failure to handle this type of cost could lead to fatal outcomes such as in the case of the famous British bank HSBC, which was reported facing a bank run problem in early 2014.

2.3 An Overview of the Financial Markets and Systems Structure in Malaysia

A financial system is (or should be) designed to facilitate the effective use of scarce resources and capital funds to promote constructive economic activities in order to foster the country‟s economic growth. It acts as a medium for fund transfers from surplus (notably savers, the largest providers of funds) to deficit economic units, with government, as the largest fund demander for activities like road and highway construction, social transfers, military, schools, and so on. In return for placing their money, financial intermediaries provide savers with rewards in the form of fixed interest, usually prorated according to the duration of the placement.

This form of fixed return (also known as *riba*) which is prohibited in Islam is mentioned in Chapter One. Instead, Islamic finance has devised an alternative non-interest approach to banking. These approaches must be *Shari'ah* compliant and fulfils Islamic concepts. This is based on the concept that all economic entities like the savers or investors should receive returns commensurable with the level of risk assumed for any investment.

Malaysia is one of the countries embraces this concept. It has actively supported the growth of the Islamic banking and finance industry since the inception of the first Islamic bank, BIMB, in 1983. Since then, Malaysia has developed systems, structures, legislation and mechanisms to support the growth of Islamic banking and finance. In the decade following the establishment of the industry in 1983, BIMB provided the main foundation for Islamic banking as the industry"s infant, and in the process witnessed tremendous asset growth and customer base enlargement (Ariff, Mohamad, Hassan and Nassir, 2008). Conducive regulatory frameworks plus government initiatives have since helped to develop the nation as a centre for Islamic finance talent and establish the country as a regional Islamic financial centre. Among key success factors encouraging this growth are Malaysia"s position as a well-developed market; the composition of its sophisticated and diverse market players; relatively liberal foreign exchange rules and administration; a conducive business environment; the country"s strategic location; its flexibility, which allows it to adopt reasonably quickly global and regulatory best practices in economics and finance policies; a mature *Shari'ah* governance framework; tax neutrality; and finally the availability of comprehensive human capital development.

Islamic banking players in Malaysia can be categorised into four different groups, based on their organisational banking structure: (1) standalone Islamic banks; (2) windows of Islamic banks that are subsidiaries of their conventional parent institutions; (3) Islamic windows under supervision of conventional banks; and (4) international Islamic banks licensed in Malaysia. This study however looks only at full-fledged (or standalone) Islamic banks in seeking to devise an asset and liability management model. It does so because the aim is to obtain fully *Shari‟ah*-compliant financial statements, including the consolidated balance sheet and comprehensive statement of income.

2.4 The Islamic Banking Structure and Governance in Malaysia

This section covers the governance and regulatory frameworks for the Islamic banking and finance industry in Malaysia, including the relevant regulating bodies overseeing the banking and finance operations. As stated earlier, it is important to consider the rules and regulations governing Islamic banking operations, so that this research model can capture the potential implicit and explicit impacts of these on a bank‟s core Treasury activities (especially in the area of asset and liability management). The section begins with an outline of the role of the Malaysian central bank and its supervisory duty in the Islamic financial system, followed by a brief introduction into the current financial system as summarised by the International Monetary Fund (IMF) in reports like Financial Sector Assessments. Finally, the section looks at the specific mechanisms governing Islamic banking and finance.

The Malaysian financial system is centralised under the purview of Bank Negara Malaysia (BNM), the country‟s central bank. Bank Negara plays a number of roles to ensure that all financial and monetary institutions meet their responsibilities and that there is broadly fair competition among all players. It is responsible for maintaining and fostering the stability and growth of the financial system. Its most important function is to maintain monetary stability, an essential pre-requisite for economic growth (Ariff *et* al., 2008, p. 5). All financial products and services which are part of the financial system, including Malaysian Government Securities, monetary and foreign exchange markets, Islamic banking and finance as well as private debt securities fall under Bank Negara"s supervision and regulation.

Turning now to the regulatory framework, for the past ten years Malaysia has continued to liberalise the financial system in order to diversify the country"s financial structure and create stronger domestic financial institutions capable of facing up to global challenges. Part of these moves was to bring in alternatives to the conventional money-taking and deposit system, notably Islamic financial products and services. As explained in Chapter 1, conventional banks are interest-bearing banks, whereas Islamic banks (also known as the *Shari"ah* compliant banks) operate on the religious principle that prohibits interest-based transactions. Each of these types of banks operates under different sets of rules and guidelines issued by BNM, although many guidelines are common to the two. Other than the central bank, the Accounting Association of Islamic Financial Institutions[15] (AAOIFI) and Islamic Financial Services Board (IFSB) provide input or suggestions to assist in drafting rules and regulations by the central bank to guide the operations of Islamic financial institutions in Malaysia. These two important bodies provide constant updates which regulate the bulk of operational issues within the Islamic banking and finance industry.

In line with the theme of this thesis, the rest of this section focuses on the operations and functions of the conventional and Islamic banking sectors, and does not cover other financial sectors. The next section (Section 2.4.1) looks at the history and operating environment of Islamic banking in Malaysia, while Section 2.4.2 covers the regulations which determine how Islamic banks should operate and be managed. These

[15] The accounting and Auditing Organisation for Islamic Financial Institution (AAOIFI) is an organisation established in Bahrain to maintain and promote *Shari"ah* standards and principles among *Shari"ah* members. It ensures that the members conform to the regulations set out in Islamic finance in order to promote a standardised reporting system among participating Islamic financial institutions (AAOIFI, 2017).

rules also determine accounting and reporting procedures and, most importantly, how an Islamic bank‟s assets and liabilities should be managed.

2.4.1 Islamic Culture, Beliefs and Economy

Both the conventional and Islamic banks need to observe legislative requirements to maintain good governance for the welfare of the society. This ensures that the banks operate in line with the objective to maintain and protect the wealth of the economy. In Malaysia, the conventional and Islamic banks are regulated by the central bank under the Financial Services Act 2013. Islamic banking operations are further mandated by the Islamic Financial Services Act 2013. The Islamic Financial Services Act 2013 follows the baseline fundamentals outlined in the *Fiqh,* the Muslim‟s jurisprudence covering all aspects of their religious life and behaviour including religion, political, social or economic activities (Ramadan, 2003). This jurisdiction envelops religious activities like prayers, fasting, *zakat* and pilgrimage, family law, inheritance, social obligations, commerce, criminal law, constitutional law and international relations that also includes war. The origination of references from *fiqh* is mainly from the source of *Qur'an and Sunnah. The* secondarily source is obtained from *ijma"* (consensus) and *ijtihad* (effort to derive juristic opinions).

Following this concept, the Islamic bank has the fiduciary responsibility to *Fiqh al-Muamalat. Fiqh al-Muamalat* regards affairs of the world, including civil and commercial transactions. It is a branch of governance specifically in Islamic economic activities. The mandates referring to the above religious requirements are contained in *Shari'ah*. It is a source of law guiding Muslims for submission towards Allah and His Prophet Muhammad (Kettel, 2011, p. 13). The Holy *Qur'an* is first source of *Shari'ah* law; like *fiqh,* the second source is the *Sunnah* or *Hadith* (other teachings of the Prophet); the third is the *Ijma* (the consensus of the *Ulema's opinion*); while the fourth is *Qiyas* (the analogical deductions). The importance of the Holy books is expressed by the two quotes shown below;

> "*I leave two weighty things for you. You will never go astray while holding them firmly. The Book of Allah and the Sunnah of His Prophet*"
>
> (The *Hadith al-Thaqalayn* in Kettel (2011, p. 13))

The above *Hadith al-Thaqalayn* verse is one of the quotes in *Hadith* illustrating the need for Islamic financial institutions to perform all activities in accordance with the expectations of Islam through *Shari'ah*. Figure 2.1 below illustrates this relationship - the interaction between Islamic banking and finance activities as a branch of economic activities in promoting the *Muamalat* aims to benefit mankind. Apart from the economic accountability, the diagram shows other religious concerns in Islam such as the *Aqidah*[16], *Shari'ah* and *Akhlaq* (moral and values) (Ismail, 1990; Saeed, Ahmed and Mukhtar, 2001). It also depicts the relationship between banking activities and the concepts of *Shari'ah*. By carrying out *Shari'ah*-compliant activities, Islamic banking institutions play key role for achievement and fulfilment of the *Shari'ah* objectives. This is why any asset liability management model for Islamic banks must consider all relative *Shari'ah* rules to ensure its holistic function. It is also the main feature which differentiates Islamic asset liability management models from conventional ones in the literature (Beck, Demirgüç-Kunt and Merrouche, 2013, p. 8).

[16] *Aqidah* is the concept of Islamic creed or articles of faith. It entails *Qur'an* formulation that includes belief in God, angels, prophets, scriptures, and the Day of Judgment. Early creeds reflected *Shii-Sunni* polemics: *Shiis* upheld the notion of the designated imamate, and Sunnis responded that the community elected the imam and that the historical order of the caliphates of Abu Bakr, Umar , Uthman , and *Ali* was theologically proper. It is a detailed formulations stressing a triad that is belief in God, the Prophet, and the Day of Judgment. *Aqidah* as constitutes to the essential belief system in Islam (Oxford Islamic Studies Dictionary, 2007).

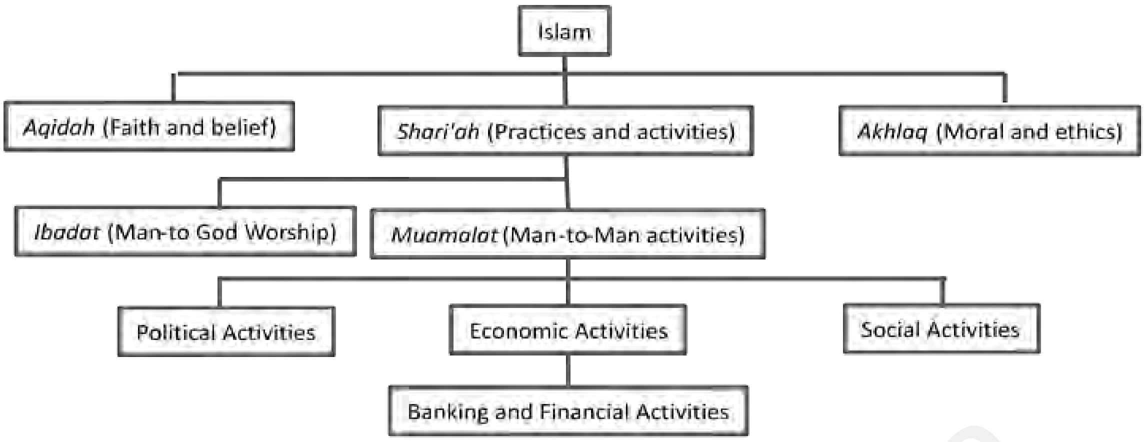


Figure 2.1: Islam, *Shari'ah* and banking and finance

Source: Kettel (2011, p. 15)

Before considering the approaches and processes for developing an Islamic-specific asset and liability management model, let us first look at the prospects for doing so and the key elements involved. Reports suggest that it was growing demands among Muslims in Mit Ghamr, Egypt, to observe their religious faith in all aspects including banking that directed to the creation of the first *riba*-free banking system in 1963. The people in Mit Ghamr were devout, and so did not want to save their money in banks, as Islam prohibits transactions based on interest or *riba* (Institute of Islamic Banking and Insurance, 2010, para. 20). Interest-free banking is considered to be the most essential element of the Islamic financial system that sets it apart from conventional banking. A quote from the *Qur'an* in *Surah Al-Baqarah* verse 275, extracted from Ismail (2010, p. 55), states that "God hath permitted trade but forbidden usury" points up the need among Muslims to stay away from *riba*. There are further verses underlying the *riba* prohibition throughout the *Qur'an* as well as the *Hadith*. In addition, *Shari'ah* also prohibits speculation (*maysir*), excessive risk taking or uncertainty (*gharar*), non-*Shari'ah* dealings (*haram*) like selling pork, alcohol, pornography, tobacco and prostitution, as well as other dealings that are contrary to Islamic teachings and beliefs.

Since the creation of the first Islamic bank in Mit Ghamr, the demand for Islamic banking operations has grown rapidly throughout the globe. Now Islamic banking system is growing very quickly, with *Shari'ah* compliant assets expected to reach a total value of 1.8 trillion USD in 2019 from 2009 (Earnst and Young, 2012). An updated source by Islamic Financial Services Board (2017) in Islamic Financial Services Industry Stability Report (2017, p. 10) reported that the Islamic banking sector reported a significant increase in its average yearly total assets growth to from 3 per centum to approximately 11 per centum since financial period quarter four 2013 till quarter two of year 2016. Apart from this, it is also reported that the industry experienced an increased annual average finances offered to the market from 3 per centum to 9 per centum from quarter four 2013 to quarter two 2016. Similarly, deposit facilities offered have also reported an increase with growth rates similar to the average annual yearly growth for finances offered to the market.

Parallel to the above growths, *Shari'ah* complying institutions like Islamic banks are mushrooming in many parts of the world. All of this makes the subject of our study worthwhile (Ariffin, 1988; Gruening and Iqbal, 2008). This study is therefore with the aim to contribute to the asset and liability management effectiveness to foster further growth to promote Islamic banking"s rapid expansion.

2.4.2 Islamic Banking in Malaysia and the Islamic Economy

In Malaysia, three types of Islamic banking structures exist. First, there are Islamic banks operating as a window of conventional banks – in other words, conventional banks that offer Islamic financial services and products within their premises. The second type is Islamic subsidiaries whose parent company is usually a conventional financial institution. Finally, there are full-fledged standalone Islamic banks which provide only products and services that are in agreement with *Shari'ah*.

Common *Shari'ah*-compliant contracts offered in Malaysia include the *Uqud al-ishtirak* (profit sharing) (*mudaraba*, *musharakah*) (Ghazali, 1994), contract of sale (*murabahah*), contract of trusts (*al-wadi'ah, wadi'ah yad dhamanah*), contract of agency (*al-wakalah*), and contract of gift (*al-hibah*) (Ismail, 2010). These Islamic financial contracts are designed to make sure compliance with the prohibitions of *riba* (interest), *maysir* (gambling or speculation), *gharar* (uncertainties), *haram* (forbidden and wrongful conduct or objects in Islam) and other *Shari'ah*-prohibited dealings. These different types of contracts outline the operational differences between the asset and liability portfolios in Islamic and traditional banks. These complexities in the balance sheets of Islamic banks can make managing them more challenging (Beck, Demirgüç-Kunt and Merrouche, 2013, p. 8) – challenges that have not really been dealt with in the literature to date.

On top of this, many Islamic banks are combating further challenges in management of their asset and liability due to different mechanisms governing their operations, such as the lack of investment in robust treasury management because of their smaller sizes compared to most of their conventional counterparts (Drummond, 2001). The Islamic banks experience specific risk exposure related to share capital, and profit margin compared to traditional risk arising from interest rate margins charged by the conventional banks. This is evident in financial transactions involving the mark-up or cost plus profit problems found in the *murabahah* (two-tier) transactions. Apart from this, the feature of profit loss sharing through *mudaraba* places the Islamic bank on an essentially contradicting nature of risk exposure than the conventional banks. The conventional banks are not engaged in the application of the profit and loss sharing modes in loan facilities. Thus, the structural nature of the credit or counterparty credit risk exposure between these two banks differs (Gruening and Iqbal, 2008, p. 145). Islamic finance is a prominent industry in Malaysia. Its growth has been significance making the country a global Islamic financial hub especially in terms of ranking by the size of *sukuk* issuance (Ismail, 2010). From then on, Malaysia is recognised as a leading practitioner of Islamic finance. From the 1960s of Islamic finance practices in Malaysia, the country has made a transition through four distinct phases. Phase 1: the establishment of Islamic financial institutions and infrastructure; Phase 2: Islamic windows in conventional banks; Phase 3: Islamic subsidiaries; and Phase 4: the liberalisation of Islamic finance. The salient features of all these phases are presented below.

Phase 1: Establishment of Islamic Financial Institutions

(a) Tabung Haji

The history of Islamic banking in Malaysia can be traced back to the birth of the world‟s first Pilgrimage Management and Fund Board in Malaysia, Tabung Haji, established under Act 8 of the Pilgrimage Management and Fund Board 1969 and Act 168 of the Pilgrimage Management and Fund Board (Amendment) 1973. Its establishment aimed to mobilise the savings of Muslims intending to perform the pilgrimage or *Haj,* and to channel these funds to permissible investments in line with *Shari‟ah* principles. The objectives of this new entity, among others were:

- To enable Muslims to save gradually to finance their pilgrimages and for other beneficial purposes;

- To help Muslims to take active and effective part in investment activities permissible in Islam, through their savings;
- To protect and safeguard the interests and welfare of pilgrims during the pilgrimage, by providing various facilities and services

Tabung Haji has pursued the above objectives with commitment and dedication, not only by efficiently and effectively managing pilgrimage matters but also by becoming an alternative entity for managing the investments of Muslims in accordance with Islamic teachings, while at the same time providing competitive returns to depositors. The board took on investments based on *bai'bithaman ajil* and *musharakah* initially in 1990.

(b) Bank Islam Malaysia Berhad

The first formal Islamic bank, as a *Shari'ah*-based financial intermediary, came into existence in Malaysia when the National Economic Congress passed a resolution in 1980 encouraging the government by allowing Tabung Haji to launch an Islamic bank. The initiative was partly influenced by the global movement to develop alternative banking systems complying with *Shari'ah* principles to serve the needs of Muslims. This aspiration led to the establishment of Malaysia"s first Islamic bank, BIMB, which came into being in 1983. The Islamic Banking Act has assigned its power regarding regulations of Islamic banks for supervision in the same way as other licensed banks. In the same year, the Government Investment Act 1983 has also empowered the state of Malaysia to issue GIIs, a sovereign security instrument based on *Shari'ah* principles to manage the liquidity of the newly established Islamic bank. With the issuance of GIIs, it enabled Islamic banks to make investment in liquid fund by investing surplus amount. The GIIs also enable BIMB to procure assets.

Phase 2: Islamic Windows

(a) Interest-Free Banking Scheme (SPTF) / Islamic Banking Scheme (SPI)

The Malaysia Government, together with Bank Negara Malaysia, has from the outset adopted a step-by-step approach to developing Islamic banking across the country, gradually expanding the number of players involved and the number of Malaysians able to access it. This led to the second phase of Islamic banking, ten years after the establishment of BIMB: the establishment of Islamic windows in conventional banks.

In March 1993, Bank Negara Malaysia introduced the "*Skim Perbankan Tanpa Faedah*" (Interest-free Banking Scheme) or SPTF. Later, this became known as „*Skim Perbankan Islam*" (Islamic Banking Scheme), or SPI for short. Under this new arrangement, conventional banks were permitted to offer Islamic banking services leveraging on their existing infrastructure and branches. Banks participating in SPI were required to have firewalls between their conventional and Islamic funds; to separately allocate a fund for Islamic banking; to establish Islamic banking units; and to appoint at least one *Shari"ah* advisor for sake for consultant on the routine operations of the Islamic banking division.

This approach was seen as the most effective and efficient way of increasing the participation of local banking institutions in Islamic banking services at the lowest cost and within the shortest time frame.

(b) Islamic Inter-Bank Money Market (IIMM)

With the increasing number of players offering Islamic banking services, there was a growing need to ensure the stability and sustainability of this new sector. In particular, there was an urgent need to establish an Islamic money market to facilitate the smooth functioning of the Islamic banking system. Such a market could provide Islamic financial institutions with both funding and the scope to adjust their portfolios in the short-term.

Consequently, an IIMM was launched in 1994 as an intermediary providing investment compliance with *Shariʿah*. The various Islamic financial instruments introduced and the active interbank investment conducted under the IIMM aimed to transfer surplus fund to banks with deficit funds, thereby maintaining the funding and liquidity necessary to promote stability in the system. Even more important, through the IIMM, Islamic banks and banks participating in the Islamic Banking Scheme (IBS) was able to match their funding requirements effectively and efficiently based on *Shariʿah* principles. Bank Negara Malaysia later issued Guidelines, in December 1993, to ensure the proper implementation of the IIMM.

Phase 3: Islamic Banks and their Affiliation

By 2003, Islamic windows had achieved wide acceptance. Bank Negara Malaysia then issued a review which called for a further step forward in the development of the sector: the setting-up of Islamic subsidiaries. The aim was that Islamic subsidiaries would give greater strategic focus and resources, as well as higher autonomy and governance, to Islamic banking operations.

Among the commercial banks that set up distinct Islamic subsidiaries were:

(1) Hong Leong Islamic Bank, whose Islamic subsidiary began life as a division before being incorporated as a separate entity in March 2005,
(2) Affin Islamic Bank Berhad (AFFIN ISLAMIC) and EONCAP Islamic Bank commenced business operations in April 2006.
(3) AmIslamic Bank started operations in May 2006.
(4) In January 2008, the largest Malaysian bank, Maybank, began to operate a new subsidiary known as Maybank Islamic Berhad (MIB).

During the same period, Malaysia adopted legal reforms to improve the efficiency of the Islamic banking and financial system and remove any impediments to these reforms.

Phase 4: Liberalisation

The integration of local Islamic banks with international Islamic banks began in 2003, when three foreign Islamic Banks were granted a license by Bank Negara Malaysia to undertake Islamic banking, namely:

- Kuwait Finance House (KFH), which commenced operations in February 2006 – the first foreign Islamic bank to be licensed by the Ministry of Finance.
- Al Rajhi Bank set up its first overseas operations in Malaysia in October 2006.
- Asian Finance Bank Berhad (AFB) was initially incorporated in November 2005, backed by a consortium of shareholders from leading Middle Eastern financial institutions such as Qatar Islamic Bank and associates (70%), RUSD Investment Bank Inc. of Saudi Arabia (20%) and Global Investment House of Kuwait (10%). Its first branch in Malaysia opened in January 2007.

This liberal and open approach to Islamic banking was designed to promote the sector‟s increased competitiveness, resilience and sustainability. All this was intended to provide benefits to the users of Islamic financial products and services.

In Malaysia, there were 12 Islamic banks under the regulations of IBA 1983 and are offering Islamic banking services.

The Islamic finance industry was expected to expand further steadily in line with its conventional counterparts. The Ninth Malaysian Plan, which covered the periods of 2006 – 2010 aimed to position Malaysia as a global Islamic financial hub.

2.4.3 Legislation and Islamic Finance Governance

The rapid evolution of Islamic finance in Malaysia has been supported by the development of a comprehensive legal infrastructure. Since 2013, Islamic banks in Malaysia follow a main framework governing Islamic banking transactions by Islamic Financial Services Act (IFSA) 2013, Financial Services Act (FSA) 2013, to replace Islamic Banking Act (IBA) (1983) and Banking and Financial Institutions Act (BAFIA) (1989) alongside with the mandates by the Federal Constitution. Relevant legislation governing Islamic financial transactions has been enforced by dedicated courts.

In addition, the Islamic Finance Arbitration Rules of the Kuala Lumpur Regional Centre for Arbitration provide a customised mechanism for alternative dispute resolution in Islamic financial services. Further alternative dispute resolution is available through the Financial Mediation Bureau, established in 2005 to help settle disputes between individuals or corporations and financial institutions.

Reporting and disclosure by Islamic banks in Malaysia follow the Guidelines on Financial Reporting for Licensed Islamic Banks (GP-i). Compliance with these is important to ensure reporting consistency and comparability between all Islamic banks, as provided for under the Companies Act 2016 and Islamic Financial Services Act 2013. These guidelines ensure that Islamic banks, like their conventional counterparts, follow comparable accounting disclosure standards thus enhancing accounting transparency, while at the same time meeting *Shari'ah* standards.

This chapter has provided an overview of the accounting and reporting standards by Islamic banks in Malaysia. In addition to these guidelines and standards, the chapter has also covered the basic elements within the Islamic bank"s income statement and balance sheet. These fundamentals form an important basis for any analysis and evaluation of Islamic bank financial statements, as part of the algebraic representation development stage and structure of maths functions, guided by the theories discussed in the next chapter, Chapter 3: Methodology and Methods.

2.4.3.1 Financial Services Act (FSA) (2013)

This act is published by the central bank of Malaysia (Bank Negara Malaysia) on March 2013. The act serves as a reference to financial institutions on regulation and supervision by the central bank on payment systems and other related entities on this subject, regulation on money market and foreign exchange market for financial wellness and stability. It has a total of 180 pages to provide a comprehensive guide on regulation and supervision to finance sectors. Regulations of this act include eighteen main parts that carry two hundred and eighty one sections with sixteen schedules not inclusive of the amendments and updates. The Financial services Act (2013) reveals the following regulations under the main parts (components) listed as follows;

- Part I: Preliminary
- Part II: Regulatory Objectives and Powers and Functions of Bank
- Part III: Authorisation and Registration
- Part IV: Payment Systems
- Part V: Prudential Requirements
- Part VI: Ownership, Control and Transfer of Business
- Part VII: Financial Groups
- Part VIII: Business Conduct and Consumer Protection
- Part IX: Money Market and Foreign Exchange Market
- Part X: Submission of Document or Information
- Part XI: Examination
- Part XII: Directions of Compliance
- Part XIII: Intervention and Remedial Action
- Part XIV: Other Powers of Bank
- Part XV: Enforcement and Penalties
- Part XVI: General Provisions
- Part XVII: Repeal, Savings and Transitional
- Schedules

Parts II, V and XIV above: „Regulatory Objectives and Powers and Functions of Bank", and „Prudential Requirements and Other Powers of Bank" serves as the main reference to this work as guide to the model‟s formulation under regulatory requirements for constraint functions of the asset liability management multi-objective model. Following are some general key provisions covered by the Financial services Act (2013):

(i) PART II of the act defines the regulatory objectives, powers and functions of banks in Malaysia. Section 6 under PART II addresses the objective to promote financial stability with the banks fostering their safe and sound operational structure, the money market and foreign exchange market should have systematic functions and governance to upkeep the image of high integrity and trustworthiness among investors and the society at large, payment systems should be secured, efficient and reliable, and financial institutions should operate with fairness, responsibility and professionally in protecting consumers‟ rights and interests in services and products offered.

(ii) The act defined the types of businesses and activities carried out by the banks in Malaysia such as

(1) taking deposits through current, deposit and savings accounts (this list is non-exhaustive,

(2) paying and collecting cheques by customers,

(3) making finances available through credit facilities to eligible borrowers meeting credit criteria,

(iii) Section 12 outlines the minimum capital funds required (also funds in surplus of assets over liabilities). With reference to this, it is specified that the licensed bank granted under Section 10 and approved under Section 11 of the act should allocate the minimum amount of capital required by the Bank Negara Malaysia. This amount should be maintained at all times regardless of the changes in the economic, operating and social environment that affects the bank.

(iv) Section 15 outlined the requirements to be complied by Islamic banks in Malaysia. It includes the requirement for the maintenance of a minimum amount of funds required by the central bank for Islamic banking transactions (Sub-section 1), and to have separate accounts and maintenance for Islamic assets and liabilities from conventional non-*Shari'ah* businesses, to conduct businesses approved by *Shari'ah* law (sub-section 1 (b)). This section continued with the Islamic bank"s requirement to set up a *Shari'ah* committee without prejudice to specifications under Section 56 (refer sub-section 30 (3) in Islamic Financial Services Act 2013). In the event of violation of these rulings will cause imprisonment for a term not exceeding 10 years or fine not exceeding fifty million Ringgit Malaysia or both, to officers convicted with the above violation.

2.4.3.2 Islamic Financial Services Act (IFSA) (2013)

This act repeals previous acts - Islamic Banking Act 1983 and Takaful Act 1984 (IFSA, 2013, p. 23). The Islamic Financial Services Act (2013) provides a comprehensive description explaining the nature of business of the Islamic banks. It includes:

(1) Section 6 of the act outlines the objectives of the Islamic bank. The bank exists to promote financial stability while complying with *Shari'ah* regulations. By doing so, the bank shall pursue operational safety and soundness for sustainability, promote integrity in all functions and transactions (including transactions within Islamic money market and foreign exchange market), to

make available safe, efficient and reliable payment systems and Islamic payment instruments, to appeal as a fair, responsible and professional in all business conducts, to strive to protect the rights and interests of consumers for all Islamic financial services and products offered.

(2) Accepting Islamic deposits through current, deposit, saving and other similar accounts not limited to the need for having businesses related to paying and collecting cheques drawn by customers,

(3) To accept money for investment accounts according to the manner compliant to *Shari'ah* law,

(4) To accept other considerations or money according to the manner prescribed by *Shari'ah* law,

(5) Provisions for Islamic derivatives to include option, swap futures or forward contracts in accordance to *Shari'ah* law; this covers the different structures of the Islamic financial derivatives like market price, value, delivery or payment obligations and the relevant rates (profits or exchange rates).

(6) Section 2 (5) of the Islamic Financial Services Act 2013 stipulates qualified financial agreements to include (1) a master agreement in respect to all transactions involved in detail, from the beginning of an Islamic financial contract to its termination. Under sub-section (b) of the same section, transactions (i.e. Islamic derivative – to be settled by payment or delivery, repurchase, reverse or buy then sell back agreement Islamic securities) qualified as *Shari'ah* compliant were also defined. There is also definition given to *Shari'ah* permissible financial collaterals subjected to an interest or right securing payment or performance of an obligation to a *Shari'ah* compliant agreement which also includes a title transfer credit support agreement. This collateral may be in the form of: (1) cash or cash equivalents like negotiable

instruments and demand deposits, (2) Islamic security, an Islamic security account, or the right to an Islamic security, or (3) futures agreement or account.

(7) Section 30 of the Act outlines the establishment and governance of the *Shari"ah* committee (see page 42 of the Act).

2.4.3.3 Conflicting Provisions and Enforcement Acts

The Islamic Financial Services Act 2013 does not define clearly the term banking business, which raises the question of whether it should mirror the operations of conventional banking. PART II of the Financial Services Act 2013, on the other hand, defines "banking business" as:

a) The business of:

   i. Receiving deposits on current account, deposit account, savings account or other similar account;
   ii. Paying or collecting cheques drawn by or paid in by customers; and
   iii. Provision of finance; or

b) Such other business as the Bank (BNM), with the approval of the Minister, may prescribe.

- The Islamic Financial Services Act (2013) does not define the „religion of Islam" clearly either, which may leave this open to many interpretations based on different sources of Islamic law.

- A financial requirement standard provided in Part V of the Islamic Financial Services Act 2013 requires prudential and financial regulation and governance in Islamic bank. This requirement also applies to conventional banks. These include, for example, capital adequacy framework, statutory reserves, liquidity framework, statistical reporting, audited financial reports, ownership control and management, and restrictions on business.

2.4.3.4 Federal Constitution

The Federal Constitution is the supreme law of Malaysia. It is the highest law of the land, providing powers to both the federal and state governments. The Constitution also provides for fundamental rights and liberties of the individual in respect of religion, education, health, security, society etc. The Federal Constitution can only be changed by a two-thirds majority of the members of Parliament (MPs).

Federal and state powers are contained in List I and II respectively. Laws and regulations relating to matters in List I (also called the Federal List) are passed by the Parliament, i.e. the lawmaker at the federal level, and are enforced by dedicated civil courts. Similarly, for matters in List II (or the State List), the relevant state legislature passes laws, which are in turn enforced by the courts having jurisdiction in that state. In addition, there is a List III, or concurrent list, containing matters in which the federal and state governments share responsibility for regulation and enforcement.

List I (the Federal List) provides that federal laws govern, among others, matters relating to civil and criminal procedure, the administration of justice, and also banking and finance. The State List provides, among other things, for the jurisdiction of *Shari'ah* Courts over Muslims, but only with regard to personal and estate matters. As a result, matters relating to Islamic banking fall under the Federal List, and are subject to federal laws enforced by civil courts. The jurisdiction of the latter is spelt out in Article 121 of the Federal Constitution, which stipulates that the civil courts have responsibility for all matters conferred by federal and state laws, except the personal law of Muslims. At the same time, Article 121 (1A) of the Constitution protects the status of *Shari'ah* courts by providing that civil courts have no jurisdiction over matters that fall within the *Shari'ah* courts‟ jurisdiction.

2.4.3.5 Central Bank of Malaysia (Amendment) Act

The Central Bank of Malaysia or Bank Negara Malaysia (BNM) is the main authority for the monetary and prudential financial regulation of Malaysia‟s financial institutions. BNM‟s main responsibilities include:

a) Implementation of all laws and regulations related to financial activities;
b) Initiating changes and amendments to laws, when necessary;
c) Issuing rules, guidelines and circulars from time to time

Section 16B of the CBA 2003 contains some important provisions, namely:

i. Section 16B (1): "The Bank may establish a *Shari'ah* Advisory Council, which shall be the authority for the ascertainment of Islamic law for the purposes of Islamic banking business, *takaful* business, Islamic financial business, Islamic development financial business, or any other business which is based on the *Shari'ah* principles and is supervised and regulated by the Bank".

ii. Section 16B (7): "The Bank shall consult the *Shari'ah* Advisory Council on *Shari'ah* matters relating to Islamic banking business, *takaful* business, Islamic financial business, Islamic development financial business, or any other business which is based on *Shari'ah* principles and is supervised and regulated by the Bank, and may issue written directives in relation to those businesses in accordance with the advice of the *Shari'ah* Advisory Council".

iii. Section 16B (8): "Where in any proceedings relating to Islamic banking business, *takaful* business, Islamic financial business, Islamic development financial business, or any other business which is based on *Shari'ah* principles and is supervised and regulated by the Bank before any court or arbitrator, any question arises concerning a *Shari'ah* matter, the court or the arbitrator, as the case may be, may:

- Take into consideration any written directives issued by the Bank; or
- Refer such question to the *Shari'ah* Advisory Council for its ruling."

iv. Section 16B (9): "Any ruling made by the *Shari'ah* Advisory Council pursuant to a reference made under para. (8)(b) shall, for the purposes of the proceedings in respect of which the reference was made:

- [If the reference was made by a court], be taken into consideration by the court in arriving at its decision; and
- [If the reference was made by an arbitrator], be binding on the arbitrator.

This section suggests that the court and arbitrator should refer to the *Shari'ah* Advisory Council (SAC) in disputes involving *Shari'ah* issues in Islamic banking and *takaful"*.

The latest Central Bank of Malaysia Act 2009 – Act 701 which came into force in September 2009, contains a new chapter which further clarifies the functions of the SAC. Key provisions include:

i. Section 53: "The *Yang di-Pertuan Agong* (YDPA) may, on the advice of the Minister after consultation with the Bank, appoint as members of the *Shari'ah* Advisory Council persons who are qualified in the *Shari'ah* or who have knowledge or experience in the *Shari'ah* and in banking, finance, law or such other related disciplines. The position of such SAC members is similar to that of civil court judges, and their decisions and opinions hold similar weight and are equally binding on other courts and arbitrators".

ii. Section 55(1): "The Bank shall consult the *Shari'ah* Advisory Council on: (a) any matters relating to Islamic financial business; and (b) for the purpose of carrying out its functions or conducting its business or affairs under this Act or any other written law in accordance with the *Shari'ah*, which requires the ascertainment of Islamic law by the *Shari'ah* Advisory Council".

iii. Section 55(2): "Any Islamic financial institution, in respect of its Islamic financial business, may (a) refer for a ruling, or (b) seek the advice, of the *Shari'ah* Advisory Council on the operation of its business in order to ascertain that it follow practices based on Islamic guidance".

Further to providing greater clarity on the functions of the SAC as above, this amendment also contains the following:

- Section 56(1): "Courts and arbitrators shall refer to any published rulings of the SAC or address Islamic banking and finance issues to the SAC for a new ruling".
- Section 56(2): "Any request for advice or ruling of the SAC shall be submitted to the secretariat (Department of Islamic Banking and Takaful, BNM)"
- Section 57: "Any ruling by the SAC shall be binding on Islamic financial institutions, as well as courts and arbitrators"
- Section 58: "Where a ruling by the SC of an IFI is different from that of the SAC, the ruling of the SAC shall prevail"
- Section 59(2): "Islamic financial institutions shall comply with any written circulars, guidelines or notices issued by the Bank (BNM)"

- Section 59(3): "Non-compliance with the rule in subsection 56(1) above amounts to an offence, and may be liable to a fine not exceeding RM3million."

It is clear from the above that any rulings made by the *Shari'ah* Advisory Council of BNM are intended to be binding on both courts and arbitrators, rather than only on arbitrators as was the case under the previous Act. The purpose of this latest amendment was to promote more uniformity and consistency in deciding and interpreting *Shari'ah* issues in any court or arbitration proceedings.

2.4.3.6 Development Financial Institutions Act (DFIA) 2002 - Act 618

The Development Financial Institution Act 2002 (DFIA) is applicable to financial intermediaries such as Bank Pembangunan, Agrobank, Small and Medium Enterprises (SME) Bank and so on. DAFIA effectively places such institutions under the purview of BNM in respect of their financial transactions. Accordingly, any Islamic banking policies issued by BNM also apply to such institutions.

Key provisions in DFIA include:

i. Section 129(1): "Nothing in this Act or the Islamic Financial Services Act 2013 shall prohibit or restrict any prescribed institution from carrying on Islamic banking business or Islamic financial business in addition to its existing business, provided that the prescribed institution shall obtain the prior written approval of the Bank before it carries on Islamic banking business or any Islamic financial business."

ii. Section 129 (3): "The Bank may, in consultation with the *Shari'ah* Advisory Council established under Financial Services Act 2013, issue directions to a prescribed institution on matters relating to Islamic banking business or any other Islamic financial business, and the prescribed institution shall comply with the written directions."

iii. Section 129(4): "The prescribed institution may, in carrying on Islamic banking business or Islamic financial business, seek the advice of the *Shari'ah* Advisory Council on the operations of such business in order to ensure that it follow practices based on Islamic guidance."

A new regulatory and supervisory framework for Malaysia embodied in the Financial Services Act 2013 (FSA 2013) came into force in June 2013, repealing and consolidating the Banking and Financial Institutions Act 1989, Insurance Act 1996, Payment Systems Act 2003 and Exchange Control Act 1953.

For a holistic view to the evolution of regulatory structure and governance since early 1980s for capital requirements, followed by and coupled with stricter supervisory standards, payment system standards, anti-money laundering and counter terrorist financing standards, accounting standards, and most recently Basel III on liquidity management standards, the following is written in line with the changes in governing Acts since 2013. In Malaysia, this was marked by the enactment of the Banking and Financial Institutions Act ("BAFIA") in 1989, which repealed the Banking Act 1973 and Finance Companies Act 1969, to provide for the integrated supervision of the Malaysian financial system, and further enhance and modernise while streamlining the laws relating to banking and other institutions. Prior to the Banking and Financial Institutions Act 1989, the legislative bases for the supervision of banks, finance companies and merchant banks were legally separate. The Banking and Financial Institutions Act 1989 gave the regulator authority to supervise all financial institutions, including those supervised on an administrative basis, under a single supervisory and regulatory regime.

Nowadays, with the new Act (the FSA 2013); the Malaysian regulatory and supervisory framework has entered a new stage of development. The FSA ensures that the laws that govern the conduct and supervision of financial institutions in Malaysia continue to be relevant and effective for the financial eco-system, while streamlining the regulation of financial institutions (persons who are licensed under the FSA to carry on banking business, insurance business or investment banking business).

2.4.3.7 The Basel Accord Standards: Basel 1, 2 and 3

Basel 1, under the 1988 Capital Accord by the international Basel Committee for Banking and Supervision (BCBS), set out requirements for calculating the capital which banks ought to set aside to cover potential losses. It was intended to cover banks in any country, based on the much debated notion that „one size fits all‟. Areas covered under Basel included capital regulation, measures of risk exposure, and setting rules specifying the level of capital to be held by active financial institutions around the globe (Gruening and Iqbal, 2008, p. 221). Basel 1 introduced a capital adequacy standard based on the risk-weighted asset composition of a bank‟s assets and its off-balance sheet exposure to those risks, with the aim of ensuring that banks had adequate capital reserves to guard against insolvency (p. 221).

The Asian and Eastern European financial crises of 1997 and 1998 prompted a second Basel Accord. Basel 2 brought in more stringent and robust supervision, risk measurements and quantifications, aiming to reinforce the robustness of the financial systems as well as to provide more equal competition between the financial players. There were three mutually reinforcing pillars (Pillar 1, 2 and 3) under the Accord.

Pillar 1 stipulates the standard capital adequacy required to be held by banks, divided into three tiers (tier 1, 2 and 3), to serve as a buffer against market risk, credit risk and operational risk. The three types (tiers) of capital classifications, adopted from Gruening and Iqbal (2008), are given in Table 2.1 below:

Table 2.1: Classification of Capital in the Basel Accords

Classification	Contents
Tier 1 (Core capital)	Ordinary paid-up share capital or common stock, disclosed reserves from post-tax retained earnings, and non-cumulative perpetual preferred stock (goodwill to be deducted). It includes common shares and retained earnings.
Tier 2 (Supplementary capital)	Undisclosed reserves, asset revaluation reserves, general provisions or general loan-loss provisions, hybrid (debt-equity) capital instruments, and subordinate term debts[17]
	Unsecured debt: subordinated and fully paid-up, to have an original maturity of at least two years and not repayable before the agreed repayment date unless the supervisory authority agrees[18]
Tier 3 (Abolished under the Basel 3 arrangements)	Note: Under the later Basel 3 arrangement, BCBS (December 2009; p. 15), this Tier 3 capital category was removed to ensure that market risks are met with the same quality of capital as credit and operational risks.

Source: Gruening and Iqbal (2008, p. 223)

The Basel 2 capital adequacy methodology has serious implications for Islamic financial institutions that are obliged to observe the principles of *Shari‟ah*. This is especially true when these Islamic institutions offer products and services based on a different kind of intermediation to conventional banks (i.e. profit-sharing, partnership, non-interest, non-speculative) and different sorts of liabilities (Grais and Kulathunga, 2007 in Gruening and Iqbal, 2008, p. 224). Interested readers may turn to Grais and

[17] Eligible Tier 2 capital may not exceed total Tier 1 capital, and long-term subordinated debt may not exceed 50 % of Tier 1 capital.

[18] This is limited to 250 per cent of a bank‟s Tier 1 capital, which is required to support market risks.

Kulatunga (2007), *Capital structure and risk in Islamic financial services*, John Wiley and Sons (Asia) publication for details on the specific requirements enacted by Basel 3.

The Basel 2 capital requirements should in principle benefit Islamic financial institutions by giving protection to depositors and profit-sharing investment account holders. It should also promote the stability and efficiency of Islamic financial institutions and their ability to withstand the risks of possible losses due to mismanagement. Theoretically, Islamic banks might be seen as requiring less of a safety cushion due to their risk transfer mechanisms as well as profit-sharing (*mudaraba*) based „deposits", since the risks incurred by the bank are also in principle borne by depositors (as *rab'ul mal* under this scheme). The bank (*mudarib*), working on behalf of the *rab'ul mal,* risks only its time and effort (under current market discipline supervision practices) and is only liable for failures resulting from non-performance of its fiduciary responsibilities. The seriousness of this would lead to the impediments of the blessings from God or *barakah*. Generally, Islamic banks may require slightly different standards than conventional banks. Examples of issues point to the need for different standards include the less risky asset-based modes of finance of Islamic banks on the one hand, but the unique risks arising from their profit-sharing modes on the other (Gruening and Iqbal, 2008, p. 223).

With these concerns, the IFSB issued a capital adequacy standard based on the Basel 2 standardised approach in December 2006. It should be noted that the „Guiding Principles" prepared by the IFSB complement the requirements of the Basel Committee.

As subsequent events showed, the Basel 2 Accords did not prove adequate to prevent further instabilities in the international financial system. Instead, and particularly from 2008 onwards, a number of serious financial crises and scandals took place around the world, leading to job losses, major company closures, and multiple bankruptcies and liquidations. This prompted the Basel Committee to revise the requirements of Basel 2 with a view to introducing yet more rigorous rules and guidelines. The result was a new Basel 3 (finalised in 2010) laying down more demanding requirements for capital adequacy through measures applying to capital ratios, liquidity ratios and leverage ratios (Gruening and Iqbal, 2008; p. 225). These more rigorous standards under Basel 3, involving much tightened supervision and capital requirements, have had some positive impacts, but have far from solved the recurring instabilities and fragilities in the world financial system. Moreover, some analysts have argued that Basel 3 has created nearly as many problems as it has solved (see, for example: Allen *et al.,* 2012, *Basel III: Is the cure worse than the disease?*). But that debate is beyond the scope of this thesis.

2.4.4 Other Governing Bodies and Islamic Financial Market Players in Malaysia

This section introduces other Islamic financial market players which contribute to regulatory decisions, governance and best practice in the Malaysian Islamic banking industry. It does not cover these in depth, but aims to provide sufficient knowledge for readers to understand their relevance to our asset and liability management model. Specifically, this section considers Malaysian capital market regulation through the Capital Markets and Services Act (2007), Bursa Malaysia guidelines and requirements for Islamic financial products and services (which have to be approved by the *Shari'ah* Advisory Council), and other guidelines issued by Bank Negara Malaysia to strengthen market participants" knowledge of Islamic financial instruments. In doing so, it seeks to highlight the differences between the compliance requirements for conventional banks and those that are unique to Islamic banks and financial institutions.

2.4.4.1 The Capital Market and Securities Act (CMSA 2007)

Malaysian capital market trading activities, including both bonds and stocks, are carried out on the Bursa Malaysia Stock Exchange (refer to Ariff *et al.*, 2008, pp. 27-31). This capital market aims to enhance economic growth by providing an efficient medium for funds transfer, a variety of ways of raising funds (important in a developing economy such as Malaysia), and a range of alternatives for smaller companies to tap into the funds market to support their growth and development.

The main regulations for this market can be found in the Capital Market Securities Act (CMSA 2007), enacted by the Securities Commission together with Bursa Malaysia (the latter is described in more detail in Section 2.4.4.2 below). CMSA 2007 contains regulations and guidelines for all long-term financial market participants. It further provides explanations of the various rules, regulations and guidelines with which all financial institutions who are players on the capital markets need to comply. These include codes for ethical conduct, recommended risk management methodologies, reporting and governing structures for compliance, do‟s and don‟ts for institutions and people licensed under the act, and so on.

As part of this, the act provides the basis for the solvency requirement for BIMB (the puzzles to the solvency math functions will be resolved in Chapter 3). However, it should be noted that Bank Negara Malaysia is the main regulating source for Islamic banking operations.

2.4.4.2 Bursa Malaysia

The Bursa Malaysia or Malaysian stock exchange began life as the Singapore Stockbrokers Association in 1930, and was later re-registered in 1937 under the Malayan Stockbrokers Association. In fact, there was no public share trading at that time: this started only in 1960. Subsequently, in 1964, a stock exchange was formed jointly with neighbouring Singapore (under the auspices of the new combined state structure of Malaysia), creating a common share trading floor between the two entities under the name of Stock Exchange of Malaysia and Singapore (SEMS). However, this lasted for only about a year before Malaysia and Singapore separated in August 1965.

In 1973, the Kuala Lumpur Stock Exchange Berhad (KLSEB) was formed when the joint currency between Singapore and Malaysia came to an end. This move in turn led to further developments in the Malaysian financial market, supported by other governmental action such as the implementation of the Securities Act in 1976. A new company was formed, under the aegis of the renamed Kuala Lumpur Stock Exchange (KLSE), to replace KLSEB. Subsequently, the KLSE Composite Index was launched in April 1986 to provide a portfolio of industrial trading options for investors as well as a benchmark for overall industry performance in Malaysia. Soon after, in 1987 and 1988, the Malaysian financial markets witnessed further growth with the arrival of real-time reporting, enabling the more rapid transfer of information to the investment community, as well as the creation of the second trading board as a medium for smaller companies to raise capital through public listing. The financial market industry continued to expand thereafter, with short-selling being reinstated in January 2007 following its prohibition in 1997 due to the Asian financial crisis.

With this solid background, Bursa Malaysia has proved itself being capable of providing solid supervision and has contributed immensely to regulations governing the development and application of Islamic financial products. Bursa Malaysia maintains a list of guidelines, which is regularly updated to reflect improvements and developments in product and services structures, Islamic banking and finance industry operations, risk management approaches, liquidity levels in the Islamic finance industry, the current economic, competitive and political environment, and so on.

In this thesis, we are concerned only with guidelines that affect the treasury function (especially in the management of the assets and liabilities of Islamic banks). Specifically, these are;

i) Requirements on items for financial reports;
ii) Islamic funds and portfolio management;
iii) The role of *Shari"ah* advisors;
iv) Risk management

2.4.4.3 Islamic Money Market

The operations of money market are critically associated the guidelines of Islamic banking. The short-term *Shari"ah*-compliant money market serves as a channel for the implementation of the federal government"s monetary policies. The instruments available in this money market allow surplus funds from one bank to be transferred efficiently (with little effort or risk) to other banks. One common form of this, regularly used by banks to maintain steady levels of funding and liquidity and promote stability in the system, are overnight arrangements for which fees are chargeable at an interbank-overnight rate.

The Islamic Inter-Bank Money Market (IIMM) was introduced in 1994 as a financial medium to provide short-term, readily available sources of funds that comply with the *Shari'ah* principles. Full-fledged Islamic banks, banks under the Islamic Banking Scheme, as well as other participants within the IIMM are able to use the market to fulfil a range of funding requirements, for both short-term funds and investment products, effectively and efficiently and in a way that is *Shari'ah*-compliant.

The mechanisms supporting and facilitating these processes are laid down in the Guidelines on IIMM, issued by BNM in 1993. These include the following types of IIMM instruments:

- *Mudaraba* Interbank Investment (MII)
- *Wadiah* Acceptance
- Government Investment Issue (GII)
- Islamic Private Debt Securities
- Bank Negara Monetary Notes-i (BNMN-i)
- Sell and Buy Back Agreement (SBBA)
- Cagamas *Mudaraba* Bonds (SMC)
- When Issue (WI)
- *Sukuk* BNM *Ijara* (SBNMI)
- Islamic Accepted Bills (IAB)
- Islamic Negotiable Instruments (INI)
- *Ar Rahnu* Agreement-I (RA-i)

The Malaysian Islamic Interbank Money Market continues to see growth in the volume of annual transactions as its products gain increasing market share. It serves not only religious needs, but it also provides wider choices to investors seeking greater portfolio diversification. Table 2.2 below, taken from the Bank Negara Interbank Money Market website, illustrates the increasing number of yearly market activities on the IIMM. These are arranged based on their respective underlying *Shari'ah* contracts, namely: *wadiah, murabahah,* other interbank financial products, negotiable Islamic debt certificates, Islamic private debt securities, Islamic commercial papers, Islamic asset-backed securities, Malaysian Islamic Treasury Bills, *Sukuk* BNM *ijara*, Islamic acceptance bills, *Ar-Rahnu* agreement-i, Cagamas *Mudaraba* bonds and government investment issues. Of these, the *wadiah* Islamic Interbank Money Market securities account for the highest volume of transactions (the *wadiah* principle in Islamic finance means safe keeping by the bank for deposits and general investments). At the other end of the scale, the most liquid instrument, Malaysian Islamic treasury bills, has by far the lowest yearly transaction volume. These carry the lowest risk and hence the lowest return compared to other Islamic money market securities. As the table shows, a variety of other products have been gaining popularity over the years since 2006.

Table 2.2: Annual Transactions of Islamic Interbank Money Market Products (2006-2014) Based on their Underlying *Shari'ah* Contracts

8/16/2015 Islamic Interbank Money Market

YEARLY ISLAMIC INTERBANK TRANSACTIONS

	Volume (RM million)								
	2006	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
Wadiah	946,225.90	1,047,073.45	1,903,772.00	2,132,112.00	2,140,170.00	2,364,646.38	1,627,437.00	1,710,800.35	1,691,752.00
Murabahah	-	40,682.87	79,784.68	54,041.97	58,650.75	56,874.79	55,423.66	26,571.86	71,827.93
	946,225.90	**1,087,756.32**	**1,983,556.68**	**2,186,153.97**	**2,198,820.75**	**2,421,521.17**	**1,682,860.66**	**1,737,372.21**	**1,763,579.93**
Interbank	256,072.41	301,040.18	242,025.90	197,980.72	212,346.82	304,515.49	399,631.15	441,803.25	418,582.89
NIDC/INID	14,885.00	7,680.00	6,889.00	15,365.00	20,503.00	26,832.00	32,811.00	46,061.00	62,381.00
IMTN/IABS/IPDS/ICP	12,166.13	79,855.95	109,771.88	36,123.16	55,463.02	67,164.79	108,092.19	92,623.48	72,403.69
MITB	5,918.16	6,474.25	6,952.60	4,597.11	6,213.62	528.16	2,341.38	2,187.72	4,050.71
BNNN/BNMN/SBNMI	59,004.78	105,397.15	116,212.39	63,672.82	80,000.71	235,734.51	312,791.66	377,363.33	296,012.76
GII/SPK	62,071.75	54,913.88	29,417.75	56,965.21	107,667.39	239.810.04	223,068.10	226,484.82	187,462.61
TOTAL	**1,356,344.13**	**1,643,117.73**	**2,494,826.20**	**2,560,857.99**	**2,688,015.31**	**3,296,106.16**	**2,761,596.14**	**2,923,895.81**	**2,804,473.59**

Source: Extracted from Bank Negara Malaysia: Islamic Interbank Money Market Securities (2015) from http://iimm.bnm.gov.my/index

2.4.4.4 Islamic Capital Market

The Islamic capital market in Malaysia comprises *Shariʽah*-compliant listed equities (Bursa Malaysia Berhad, 2015) that have been approved as such by the SAC. The SAC determines which securities are *Shariʽah*-compliant, and provides a list of these to the Securities Commission for listing on Bursa Malaysia. This list is updated twice a year. In drawing up the list of *Shariʽah*-compliant securities, the SAC takes into account the following aims and criteria:

- To help investors who are looking for *Shariʽah*-compliant investments on Bursa Malaysia
- To represent a centralised platform for all *Shariʽah*-related matters
- To promote disclosure and transparency in business dealings and operations among *Shariʽah*-compliant firms and institutions
- To enhance the Islamic capital markets Development

- To support the development of Islamic products and services
- To ensure that all *Shari'ah* permissible and non-permissible activities are reported clearly. The reporting method is based on clear distinctions between how these two categories of activities generate revenue. In doing this, the SAC uses a reference termed *Ijtiha;* that is *Shari'ah*-based reasoning

Most transactions within financial markets, such as lending and brokerage activities, are allowed by *Shari'ah.* But there are some exceptions, as follows:

- Alcohol
- Tobacco
- Gaming
- Arms manufacturing
- Life insurance; and
- Pork and non-halal food production, packaging and processing or any other activity related to pork and non-halal food

In addition, companies meeting the following criteria are excluded from being listed on the Bursa Malaysia as *Shari'ah*-compliant:

- Companies that are highly leveraged or exceed certain thresholds for solvency tests, as measured by debt ratios and debt repayment ratios. Moreover, if there is evidence that a company has an unacceptable level of leverage on an asset, the company or that particular asset cannot be listed.
- Companies with earnings in the form of cash or near cash, or with unacceptable levels of receivables to total assets.
- Companies with a liquid-to-illiquid asset ratio above the levels allowed by *Shari'ah* principles and generally regarded as acceptable by *Shari'ah* scholars.

- Companies whose cash and cash equivalents (liquid assets) ratio to total asset ratios exceed the percentages allowed under *Shari'ah* principles and under generally accepted principles.

2.5 Bank Islam Malaysia Berhad (BIMB): Internal Risk Supervision, Treasury Division and ALCO

This section includes the main bodies or departments responsible for asset liability management decisions. BIMB"s is referred as the case example to provide this understanding. The sub-section focuses on the role of the asset liability management committee (ALCO) and the treasurer who are responsible for BIMB"s core operational balance sheet management. It was noted in Chapter 1, the role of a bank"s treasurer is crucial for the bank"s survival. A weak or improperly managed treasury system can have devastating consequences, including even the collapse of a bank. Thus the health of a bank lies in the hands of the carefully managed treasury system.

The treasury manages asset and liability risk exposures (commonly interest rate and liquidity risks) with regard to income generation. This type of activity is also known as balance sheet management. As mentioned earlier, balance sheet management needs to be holistic and strategic, rather than tactical. This generally means looking at the medium term – up to say five years (Choudhry, 2007, p. 216). The unit responsible for managing these aspects is the Asset Liability Management Committee (ALCO). Traditional asset liability reporting processes within commercial banks are usually focused on variations in interest income which can affect income forecasts and create volatility (Choudhry, 2007, p. 327). The ALCO is often responsible for setting and implementing asset liability management policies covering these contingencies, as well as dealing with the money market (front-office) and back-office operations and supervising office reporting and risk management.

The committee normally consists of the heads of internal businesses – in other words, very senior people. It supervises the senior management level below that. This reporting relationship can vary slightly from one bank to another, but the fundamental role played by the ALCO remains the same.

The comprehensive organisation chart in Figure 2.2 below, taken from BIMB, illustrates the bank‟s governance structure with *Shari'ah* influence on ALCO and other operational functions of the bank. We can see from this that the asset and liability management function is one of the main treasury functions, reporting to the Deputy Chief Executive Officer. All ALCO functions in fact need to work closely with other important units of the bank, including the compliance, risk management and *Shari'ah* divisions, and never in isolation. This particularly applies in today‟s increasingly complex business environment, and in the sophisticated business setting of a banking institution. This complexity and sophistication demand transparency and frequent and better communication between operating divisions. For example, banks nowadays often oblige their various departments to constantly update one another on their current progress, plans and financial status.

Figure 2.2 depicts the diagram of the governance structure of BIMB. We can see from the chart showing different reporting lines based on the function and position of the respective committees. All Management (operational) committees are governed by the Board Committee comprising of the *Shari'ah* Supervisory Council‟s monitoring imposed on to the Board of Directors with a group of appointed shareholders‟ representatives to make strategic decisions on behalf of the shareholders. The Audit and Examination, Nomination and Assessment, Remuneration, Board Financing Review, and Board Risk Committees are reporting directly to this of Board of Directors. Under this reporting lines are the Management (or Operational Team), responsible for all communications relating to the operations of BIMB. The team reports to the bank‟s Managing Director who will then communicate all these details strategically to the Board of Directors of the bank. The bank‟s Financing Committee will also be reporting directly to the Board Financing Review Committee to ensure that all checks and balances are attained especially with regards to the bank‟s financial position (i.e. liquidity, credit management, solvency, quality of financing assets and so on).

We can see here that there are several aspects of risk management within the reporting lines of BIMB. Beyond operational and compliance risks management through the multiple layers of Management Committee reporting, we observe that there are also check and balances between direct communications by the Financing Committees to Board Financing Review Committee and Management Risk Control Committee to Board Risk Committee. This is an important way to promote „internal accountability‟ to reduce information asymmetry gap between the top management.

The highlight of this discussion is on the standalone unit of the Asset Liability Committee established by BIMB to manage the bank‟s assets and liabilities performance. This feature encourages a distinctive reporting that contains information exclusive to reflect the asset and liability management performance helpful to this research. Informational contents from reports by this division will be solicited and analysed to find patterns of operational and strategic asset liability management strategies. This approach is helpful to the development of multi-objective asset liability optimisation model.

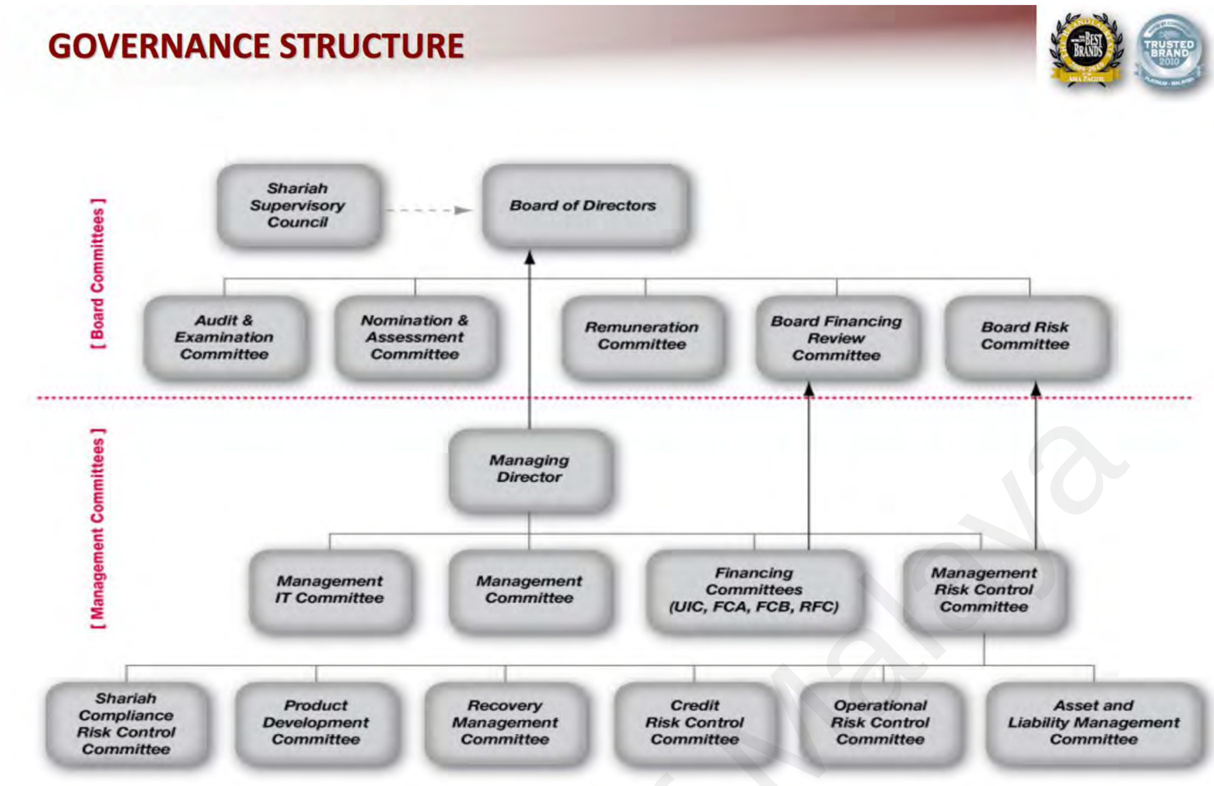


Figure 2.2: Bank Islam Malaysia Berhad Organisation Chart

Source: Adapted from BIMB Malaysia‟s Website on August 25, 2017 from http://www.bankislam.com.my/en/Documents/cinfo/BankIslam-AnalystBriefing.pdf

In order to have clear reporting lines and avoid redundancies and overlaps in task delegation, everyone within a unit has to be educated about their respective roles and responsibilities. Choudhry (2007) produced a tabulated overview of the responsibilities and missions of an ALCO. We have customised these to show the actual roles played by the ALCO in BIMB, the subject of this study.

Table 2.3 below lists these roles and responsibilities, in conjunction with the committee‟s general missions.

Table 2.3: Main Missions of ALCO and How these Relate to the Elements of the Asset Liability Management Model

Mission	Components	Similar elements in asset and liability management model
ALCO management and reporting	• Formulating asset liability strategy • Management reporting • Agenda and minutes	• Investment asset allocation strategy can be formulated using the model as a benchmark to achieve an

	• Assessing liquidity gaps and interest-rate risk reports • Scenario planning and analysis • Interest income projections	optimum asset combination. • Liquidity and gap management is contained in the liquidity constraint function developed in accordance with the liquidity guidelines provided by the central bank. • Interest income can be derived from an optimum combination of assets and liabilities, using the model.
Asset management	• Managing bank liquidity book (through Certificates of Deposits of Treasury Bills) • Managing the FRN book • Investing bank capital	• Liquidity management of the bank can be implemented by pairing different Islamic money market or *Shari'ah* permissible investment instruments. • The general capital requirement constraint captures the minimum capital requirement the Islamic bank needs in asset liability management
Asset liability management strategy	• Yield curve analysis • Money market trading	• Market rate monitoring is achieved by meeting the threshold held in the market risk constraint. • Adjustment to the asset and liability mix is automatic. • An updated combination is immediately available once new inputs are put into the model.
Funding and liquidity management	• Liquidity policy • Managing funding and liquidity risk • Ensuring funding diversification • Managing lending of funds	• The bank"s specific liquidity objectives are brought together and reflected in the liquidity requirement constraint. • Once a funding need is triggered, the asset mix required to support the funds shortage will be obtained. Managers can then choose either to follow the suggested asset mix or to redraft a new plan to reflect the new funding needs. • The redrafted plan should be input into the system to allow for a new allocation and computation of assets and

		liabilities.
Risk management	• Formulating hedging policy • Interest-rate risk exposure management • Implementing hedging policy using cash and derivative instruments	• The interest/market rate requirement is reflected in the market risk constraint. • Pairing of assets and liabilities will be carried out in accordance with changes in the market, by entering new market data once it is available.
Internal treasury function	• Formulating transfer pricing system and level • Funding group entities • Calculating the cost of capital	• The computation technique for the cost of capital follows an approach which draws on methods used in both the literature and the banking industry in general. Choudhry (2007) included commonly used methods for the derivation of a bank"s cost of capital by the treasury unit.

Source: Adapted from Choudhry (2007, p. 328), Bank Asset and Liability Management: Strategy, Trading, Analysis, Wiley and Sons (Asia) Pte, Ltd. with modification.

2.6 Unique Problems in Islamic Bank's Asset and Liability Management

It is of particular importance to understand the unique structure of the assets and liabilities of Islamic banks. Given the fact that both Islamic and Conventional banks share common risks (i.e. economic, market, social, regulatory, credit, liquidity risks and so on), the underlying contractual nature of the assets and liabilities, the transactions, processes involved as the consequence to the arrangements stipulated by the *Shari'ah* compliant contracts exposes the Islamic banks to risks that are unique to Islamic banks. Section 2.6.2 covers specific issues giving rise to these differences.

2.6.1 Problems Inherent in an Islamic Bank Balance Sheet Structure

Although both Islamic and conventional banks work in the same operating environment in Malaysia, the two types of banks report based on two different frameworks. In Section 2.4.2 earlier, we covered diverse structure governing the functionality of Islamic banks, namely: AAOIFI, IFSB, and BNM. Between them, these regulatory bodies seek to provide standardised guidelines and references for *Shari"ah*-compliant banks to follow, which in turn are the cause of the unique balance sheet structure found in Islamic banks.

According to special arrangements under the *Shari"ah* law, an Islamic bank"s assets and liabilities take a slightly different structure than the traditional interest-based banks. The assets and liabilities of the former banks are made up of different *Shari"ah* contracts based on Islamic teachings, in order to meet religious requirements. This approach determines the unique design and purposes of specific products or services offered by an Islamic bank. Not only are the design of such products and services affected by Islamic principles, but also the differing structures of these products and services has influence over the system of management of asset and liability, its objectives and risks of the bank.

2.6.2 The Unique Features of an Islamic Bank's Asset Liability Management

There are important differences in asset and liability management between conventional interest-based banks and Islamic banks. For a start, Islamic banks have a distinct balance sheet structure which enables them to engage the „pass-through" risk borne by *mudaraba* depositors, which in turn minimises the level of risk assumed by shareholders and the bank. Having said this, the IFIS provides that *mudaraba* deposits must be included in the total capital buffer for capital adequacy calculations. This arrangement reduces the normal asset liability mismatch problem to a lower level than in conventional counterparts, by linking depositors" returns with the returns of the Islamic bank. In addition, these banks differ in terms of their asset structure. A conventional bank earns fixed interest income regardless of its economic performance, and thus bears a lower credit risk. On the other hand, the assets of Islamic banks are mainly asset-based or asset-backed, and thus carry a higher level of credit risk that reflects the customer‟s potential inability to fulfil interest payments. An Islamic bank‟s credit risk is somewhat reduced because its collateral is backed by real assets (Jobst, 2007). In sum, an Islamic bank‟s lending power is dependent on the availability of real assets in the economy.

In any Islamic financing contracts, whether for tangible goods or commodities, the assets are purchased first before being sold to the customers. This is the financing concept practiced by Islamic banks under *„bai"* (sale) *and „ijara"* (leasing) *Shari"ah*-based contracts. This is different from conventional banks, which provide customers with personal or business loans so that they (the customers) can finance the acquisition of assets, which in turn often serve as guarantees for the loan services. These different scenarios create different risk exposures for conventional and Islamic banks. We can see that Islamic banks are exposed not only to risks from financing customers but also to risks that could arise from fluctuations in the value of the purchased assets.

Another feature which differentiates the risks associated with Islamic banks from a traditional one is the general lack of liquid securities on the asset side. This is not an inevitable or inherent feature of Islamic financing, but rather a temporary phenomenon that will however persist until a well-functioning securities market for *Shari"ah*-based instruments is developed.

The Islamic banks cannot issue interest based debt (i.e. conventional bonds or to involve conventional based securitisation) to finance an asset acquisition. This prohibition leaves the Islamic bank in lack of financial leverage and loss of good investment opportunity in times of rising economic growth. Nevertheless, compared to the conventional bank, the Islamic bank will show a lower leverage balance sheet position. This means that the Islamic bank will have less exposure to solvency problems especially during a financial crisis. The most recent financial crisis, for example, was accelerated by excessive leverage and complexity in the financial system, which developed multiple layers of intermediaries to a point where the asset financing and claims became remotely unsecured (Gruening and Iqbal, 2011).

There is still an asset-liability gap management problem for Islamic banks due to shortage of money market or near-term financial instruments. The Liquidity Management Centre and the International Islamic Financial Market in Bahrain, among others, have done excellent work in tackling this issue. These efforts introduced the new innovation in the area of Islamic liquidity products such as *sukuk.* The first *sukuk* was issued in Malaysia in year 2000 which was then followed by Bahrain in year 2001 and the Islamic Development Bank (IDB) in year 2003. More *sukuk* issuance was seen from then on by many countries and corporates. This trend has become a common stream for capital on a regular basis in Malaysia. Although *sukuk* market in Malaysia is quite established, more efforts to promote efficient exchanges should be in place (Al-Amine, 2008).

To support growth, the Islamic banking and finance industry needs an efficient capital market otherwise; an environment which is not conducive for fund raising could hinder Islamic banks seeking to provide an alternative banking channel for the economy. An environment which provides liquidity and price transparency would foster the growth of this secondary market. If say that the conventional market has been over-subscribed, but the lack of liquidity of the Islamic financial market means it is not an attractive alternative that would be a missed opportunity. Hence, the increasing demands for liquidity among market participants, especially those seeking *Shari'ah*-compliant assets.

2.6.2.1 The Nature of the Islamic Banking Business

This section elaborates the nature and business operations of Islamic banks. Let us begin with the following statement from the Islamic Financial Services Board (IFSB), which sets out the meaning of Islamic bank from a *Shari'ah* perspective and outlines how it should work in the economy according to Islamic concepts and teachings. According to Malaysian law, an „Islamic bank" is defined as any company/organisation having offices and branches in Malaysia, which operates Islamic banking businesses with a valid license approved by the Central Bank (Bank Negara Malaysia). Islamic banks are recognised by the Malaysian government as legitimate financial institutions offering *Shari'ah*-compliant products and services only when these conditions are fulfilled. The IFSB further defines the „Islamic banking businesses as activities with aims and operations which do not contain any elements disapproved by the Islamic religion and *Shari'ah* law.

In a document entitled "Guiding principles of risk management for institutions (other than insurance institutions) offering only Islamic financial services", the IFSB has provided a blueprint for risk management within full-fledged Islamic banking institutions. The IFSB has also produced other key guidelines to help Islamic financial institutions deal with risks classified under the six standard categories[19], capital adequacy requirement methodologies, risk-weighted asset management and others. These blueprints will assist us in the formation of our asset and liability optimisation model. Further details of the six types of risks, as well as the mitigation and management techniques for these provided by IFSB, are given below.

[19] The guiding principles set out by the IFSB covers risks classified under the six main categories such as the credit risk, market risk, equity investment risk, liquidity risk, rate of return risk and operational risk (IFSB, 2005).

2.6.2.2 Liquidity Risk Management

Liquidity risk is a potential mishap to financial institutions (other than insurance institutions) offering only Islamic financial services if it is not managed properly. This risk emerges from the inability of the financial institutions in meeting either their short term commitments in reserving funds to cater to increases in lending needs of the economy or in the process of providing credit facilities without causing inadmissible expenses.

Liquidity risk can emerge because of the changes in the financing/ credit driven market such as loan financing. This risk is commonly driven by different elements sprouting from the institutional or systematic factors in the market. When interactions between institutional and systematic market elements fail (i.e. poor repayments or drop in credit ratings) liquidity risk will suffice. During liquidity crisis, an Islamic financial institution may confront liquidity problems such as the sudden uncontrollable overnight withdrawals[20] (also known as financial *sunspot* (Barinci and Chéron, 2001; Eatwell, Milgate, and Newman, 1992) caused by the market‟s loss of confidence towards banking reliability, huge sell-off of assets which have sudden impact on economic equilibrium which then shifts other factors affecting consumer demand and financing cost for financial products. Islamic banks with joint venture account holders known as the Investment Account Holders (IAH) based on the *mudaraba* contract will experience greater challenge in managing liquidity risk than their conventional interest-based competitors. This is because the Islamic money market instruments and system has yet reached its maturity (Abdul-Rahman, 1999). The Islamic Money Market is still lack in the variety of short term financial instruments. Even if there is product availability, systems promoting the efficiency of exchanges is in

[20] See Barinci and Chéron (2001) for more readings on financial sunspots (such as examples on sudden withdrawals) and business cycles in constrained economies.

it infancy (Abdul-Rahman, 1999). Without a proper and efficient platform for liquidity management, liquidity risk cannot be managed promptly. Consequently, the domino effect of this risk will snowball causing other risks such as credit risks and therefore credit crunches which leads to potential financial crisis if left untreated (Wojnilower, Friedman and Modigliani, 1980).

The Islamic financial institutions are also facing fund raising challenges with *Shari'ah* compliance and avoidance of the non-*Shari'ah* permissible transactions. An evident example for the liquidity problem faced by Islamic banks is the absence of liquid or efficient market to allow for money market transactions and exchanges to promote quick conversion of financial instruments into near cash mechanisms which was mentioned earlier. The *sukuk* market for example is less liquid compared to conventional bonds market (Raei and Cakir, 2007). The central bank has been channelling their efforts in improving this condition thorough an established financial market for efficient exchanges to enhance liquidity. The central bank maintains the soundness and functionality of all facilities within this market so that there should not be any obstacle during the exchange which will cause transaction delays and risks related to illiquidity. For financial institutions, this process is supported by the *Shari'ah* board in ensuring that facilities promoting this liquidity are *Shari'ah* compliant and that there is nothing non-permissible by the *Shari'ah* law. The *Shari'ah* Board holds the right and fiduciary duty in contributing their *Shari'ah* knowledge in the process of determining what is permissible and non-permissible under this law. In the same way, they are also the referral for the portfolio managers in event when he needs advice on the legality of a transaction or investment in the eyes of *Shari'ah* law. With this process, the Islamic bank avoids potential lawsuit and damaged image as an entrusted financial manager (Sundararajan and Errico, 2002).

2.6.2.3 Credit Risk Management

The IFSA 2013 has also provided a definition to map accurately the credit risks arising within Islamic financial institutions. Under Principle 2.2 of the IFSB risk management guidelines, credit risk is defined as the risk arising from counterparty"s inability to meet its financing obligations in accordance with the agreed terms outlined in the given contract. Such exposures usually arise within financing assets based on *murabahah* and diminishing *musharakah* contracts, as well as *ijara* (IFSB, 2005). Table 2.4 below sets out in detail the relevant guidelines contained in Principles 2.1, 2.2, 2.3 and 2.4 of the IFSA 2013 risk management guidelines.

Section 223 of the IFSA 2013 stipulates that the finance minister may empower entity not within the governance or oversight of the central bank and engages in Islamic financial intermediation activities as Islamic financial institutions and that section 223 (b) continues that if the Islamic bank poses risk due to financial instability arising from liquidity or credit risk (including imperfect credit risk transfers), the bank is subject to provide an official contract of agreement relating to financial collateral that includes a title transfer credit support agreement, with respect to one or more qualified financial transactions under this master agreement.

Noted in Table 2.4 of the IFSB *Credit Risk Management* Guidelines, Principle 2.1 states that the Islamic banks should have in place strategies to prevent and manage credit risk exposures and Principle 2.2 contains that credit risks arising from counterpart or third party should also be accounted in the process of credit risk exposure assessment. Principle 2.3 of the act states that the Islamic financial institutions should have proper mechanisms to measure and report its credit risk exposure and Principle 2.4 outlines that the Islamic financial institution should ensure that the credit risk managing and mitigating tools and techniques to comply with *Sharī'ah* principles.

Table 2.4: IFSB Risk Management Guidelines

Principle 2.1	Islamic Financial Services Institutions (IIFS) shall have in place a strategy for financing, using various instruments in compliance with Shari'ah, whereby it recognizes the potential credit exposures that may arise at different stages of the various financing agreements.
Principle 2.2	IIFS shall carry out a due diligence review in respect of counterparties prior to deciding on the choice of an appropriate financing instrument.
Principle 2.3	IIFS shall have in place appropriate methodologies for measuring and reporting the credit risk exposures arising under each Islamic financing instrument.
Principle 2.4	IIFS shall have in place Shari'ah-compliant credit risk mitigating techniques appropriate for each Islamic financing instrument.

Source: Adopted from website http://www.ifsb.org

2.6.2.4 Market Risk Management

Market risk occurs when an Islamic bank offers *ijara*[21] (IFIS, 2005). Under an *ijara* contract, the lessor (Islamic bank) is disadvantaged when the leased asset‟s residual value is below its market value due to fluctuations in market rates. Similar consequences occur if a lessee terminates the *ijara* contract earlier than the agreed term. In addition to this, market rate volatility can cause Islamic banks higher mark-up risks. This occurs when the Islamic bank faces difficulty in determining the cost-plus margin charged in trade financing contracts (Gruening and Iqbal, 2008).

[21] An *ijara* contract is similar to financial leases offered by conventional banks. The differences between *ijara* and conventional financial leases are that *ijara* requires the leasing agency (Islamic bank) to own the leased object for the duration of the lease (resembling security to the bank) and that there is no compound interest in the event of a default or delay in the instalment payments (Gruening and Iqbal, 2008).

Profit-rate risk meanwhile can occur when changes in the net profits due arise from changing values in either assets or liabilities because of market rate changes.

On the balance sheet‟s liabilities side, Islamic banks accept investment accounts on the basis of *mudaraba* and then use those funds for asset-backed financing instruments consistent with *murabahah* (i.e. *ijara*) (Gruening and Iqbal, 2008*,* p. 23). Under long-term *murabahah* and long-term *ijara,* settlements are on a deferred basis, and so are susceptible to volatility in market rates. In the event of unfavourable market rate movements, depositors under *mudaraba* contracts need to absorb the losses in the settlements affected: unlike depositors in conventional banks, they do not have for a guaranteed fixed claim. Such depositors also of course have the option of switching their investments to commercial banks, if they see the market moving unfavourably which exposes the Islamic banks to additional displaced commercial and withdrawal risks not faced by their conventional counterparts. In the event of losses being incurred as a result of unfavourable market rate movements, both shareholders and depositors (investors) need to absorb these under the profit-sharing agreement between them and the bank.

Market risk is defined as risk of losses, in both on- and off- balance sheet positions, due to movements in market prices such as fluctuations in the values of tradable, marketable or leasable assets (including *sukuk*), or in off-balance sheet individual portfolios (e.g. restricted investment accounts). It further includes risks that relate to the current and future volatility of the market value of *murabahah* assets intended for delivery over a specific period, and thus subject to pricing based on interest rate movements in the market. The dynamic structure of foreign exchange rates can also contribute significantly to market risk (IFSB, 2005). In order to mitigate this type of market risk and guide Islamic financial institution in managing it, the IFSB set out Principle 4.1 below:

Principle 4.1: An Islamic financial institution shall have in place an appropriate framework for market risk management (including reporting) in respect of all assets held, including those that do not have a ready market and/or are exposed to high price volatility.

According to the IFSB, market risk is particularly prevalent in operating *Ijara*. Here, the lessor is exposed to the volatility in the market price of the leased assets, which in turn can affect the residual value of those assets. In the event of early termination of the lease collateral, such as when a lessee defaults on their lease obligations, the lessor might then be obliged to take back the leased assets at a lower residual value than the original market price. Another example is the *salam* contract, in which the Islamic financial institution is exposed to commodity price fluctuations because it is obliged to hold the asset specified in the contract over a longer term until the asset in question is disposed of (IFSB, 2005).

The IFSB encourages the Islamic financial institution to employ recommended balance sheet techniques to minimise their exposure to market risk. These include the need to determine profit ratios with due regard to the varying conditions of the market (IFSB, 2005, p. 25).

2.6.2.5 Risk Associated with Profit and Loss Sharing (*Mudaraba*) Contracts

A *mudaraba* or profit and risk sharing contract is an omnipresent financing system in Islamic keeping money. In a work of art (that is medieval, not present day) *mudaraba*, the *rab'ul mal* (which means contributor financial specialist) gives cash to a *Mudarib* (which means chief) who utilises it to direct a settled upon business, and afterward comes back to the investor speculator the foremost and a pre-set extent of the profits (Iqbal and Mirakhor, 2011). When he or she has turned over the cash as an underlying speculation, the contributor financial specialist has the privilege to confirm that the administrator is conforming to the terms of the agreement, since the director is not at risk for any misfortune that happens throughout the business aside from when such misfortune happens due to a rupture of trust. There is an understanding that the administrator will act as indicated by the standard routine of any sensible businessman (Iqbal and Mirakhor, 2011).

Advanced Islamic banks utilise *mudaraba* contracts to produce liquidity and turn a profit, going about as go-betweens between contributor financial specialists and the supervisors of business endeavours. As a result, cutting edge Islamic saving money takes the exemplary *mudaraba* contract and scales it up: the contributor speculator turns into the *Rab'ul mal* in connection to the bank, which as *Mudarib* deals with the contributor financial specialist's cash. In the meantime, the bank takes on the position of the *Rab'ul mal* in connection to the business venture in which the bank contributes, which is the *Mudarib* in connection to the bank. Under this scaling rule, the bank can acknowledge cash from numerous contributor financial specialists through the *mudaraba* legally binding structure and, thus, can put it in a few unique ventures in the same *mudaraba* authoritative shape. In the event that the ventures turn a profit, the undertakings themselves, the bank, and the contributor financial specialists are qualified for a foreordained rate of that profit. Should they turn a misfortune; the contributor financial specialists (and perhaps the bank, contingent upon its working standards) partake in a foreordained rate of the misfortune. The endeavours themselves (furthermore the bank) can go off the misfortune to their contributor speculators, since the undertakings are considered to have "lost" the ability and work put resources into seeking after the agreements.

Mudaraba creates many problems for conventional accounting. First, there is conventional accounting‟s „entity theory‟ which refers to “accounting draws meaningful boundaries around business entities for the purpose of audit.” *Mudaraba* contracts blur the boundaries between the entities taken into consideration for the purposes of accounting and their owners. In a *mudaraba* contract, the depositor-investor who contributes capital in return for a share of the profit or loss „owns‟ that capital. The bank is „managing‟ it and investing it in productive enterprises. In conventional accounting, the entity concept is “a separation between owners and corporate entities, morally insulating the former from the decisions of the latter; if owners disagree with a particular decision, they can vote at shareholders‟ meetings to change policies or, more simply, disinvest.” However, *mudaraba* contracts are a moral/ethical structure. “The bank‟s own venture, its own corporate status, meanwhile, is not a separate entity from the depositor-investors‟ capital, but is rather an extension of that of the depositor-investors (Gambling and Karim, 1991: p.103; Hamid, Craig and Clarke, 1993)”. Silverstein and Urban (1996) encapsulated this dilemma as follows: “Given this, how should an accountant contextualise, as it were, the entity for the purposes of an audit? How should the accountant draw meaningful boundaries around and abstract from the business practices of the depositor-investors, the bank, and the enterprises in which the bank has invested depositor-investors‟ money?”

The second problem that *mudaraba* poses for conventional accounting concerns the separation of ownership from management in its corporate form (Berle and Means, 1991; Maurer, 1999). When corporations are managed by one set of individuals (managers) and owned by another (shareholders), the managers are obliged to work for the sake of shareholders. In other words, managers are the „agents" of the shareholders, who are the „principals" of the corporation. However, the separation of ownership from management means that shareholders do not have access to the same information about the day-to-day operations of the corporation as the managers; and the postulate of self-interested maximisation suggests that managers will tend to act in their own interests rather than those of shareholders. The „information asymmetry" between agents and principals offers scope for the free rein of managers" self-interest.

The third problem that *mudaraba* faced by conventional accounting is related to income. To calculate income, value of an entity must be determined first. In Islamic banking point of view, calculations of such value create the possibility of *riba*. *Riba* applies here because each calculation adds some value to the real property without including the risk involved (Maurer, 2002).

2.6.2.6 Islamic Bank Balance Sheet Preparation and Problems

As mentioned in Chapter 1, the quality of asset and liability management promotes confidence in a banking operation. Customers place their deposits with a bank, confident they can withdraw them when they wish. If doubt arises over the ability of a bank to pay out on demand, all its business may be lost overnight.

More specifically, asset and liability management covers a wide spectrum of areas, including strategic planning and implementation and control processes that affect the volume, mix, maturity, profit rate sensitivity (in conventional banks interest rate sensitivity), quality and liquidity of a bank"s assets and liabilities. In broad terms, liquidity refers to the ability to trade instruments quickly at prices that are reasonable in light of the underlying demand/supply conditions. The aim is to harness the depth, breadth and resilience of the market to obtain the lowest possible costs for any given transactions (Pervez, 2000). A consummately fluid resource is defined as one whose full present esteem can be acknowledged, i.e. transformed into buying power for products and ventures, instantly (Tobin, 1987). Money is flawlessly fluid, thus for common sense intentions are request stores and different stores transferable to outsiders with check or wire, as are interests in transient fluid government securities (Abdul-Rahman, 1999). The significance of liquidity rises above the individual establishment, since a liquidity shortage at one foundation could incite more extensive systemic repercussions – even to the point of making damage the entire financial dependability of a nation. It is in this way critical for banks to have satisfactory liquidity potential to have the capacity to get adequate finances immediately and at a sensible cost (Heffernan, 1996). In accordance with the over, the essential objective of benefit and risk administration of a bank is to create an extensive, amazing, steady and developing flow of net profit/premium wage. To achieve this, a bank needs to attempt to locate an ideal mix between levels of advantages and liabilities, and also of financial risk.

These worries over resource and obligation administration are similarly important to Islamic banks, since the last hold illiquid resources while their liabilities are fluid; and on top of that hold resources that are flighty in esteem which regardless need to ensure the estimation of their liabilities. To put it plainly, since Islamic banks take after extensively an indistinguishable structure and attributes from a business bank as far as their asset report, they are not safe from liquidity chance. Any confound amongst stores and speculation financing may open Islamic banks to liquidity issues. Then again, if these banks keep up an excess of liquidity to stay away from such issues, this may thus hurt their profitability. In this way, striking the correct harmony between the two targets of security and profitability is the essence of the liquidity administration issue for the entire business of Islamic banks as financial delegates.

A full comprehension of a bank's operations can be accomplished just by comprehension the different components contained in the bank's accounting report. Resource and obligation administration, including as they do the activation and use of assets in accounting reports, lie at the money related heart of a bank. All the more particularly, the benefit and obligation administration of a bank's monetary record includes key arranging and execution and control forms that influence the volume, blend, development, loan fee affectability, quality and liquidity of a bank's advantages and liabilities. Therefore, in the managing an account business it is essential to accomplish the ideal structure, piece, blend and level of benefits, liabilities and budgetary risk.

Resources in the managing an account division normally include an arrangement of things claimed by all banks, despite the fact that the structure of asset reports may differ essentially from bank to bank, contingent upon the business introduction, showcase environment, client blend or financial environment. The piece of a bank's accounting report is typically the after effect of advantage/obligation and risk pooling among choices involved. Then again, liabilities in the keeping money part have a tendency to mirror the way of a run of the mill business in view of low edges and high influence. Subsequently, many banks' monetary records have a low cash-flow to-liabilities proportion – a proportion which would ordinarily be unsuitable to other non-money related administrations organisations. Keeping in mind the end goal to direct and moderate this, the satisfactory level of risk connected with such a structure is regularly measured and recommended as far as fund allocation based on capital prerequisites, which are thusly connected to the bank's advantages. These prerequisites influence the financing structure of a bank, which can affect its cost of operation and its benefit potential and risk levels. Table 2.5 below sets out the compositions of a bank‟s Balance Sheet.

Table 2.5: Compositions of Bank Balance Sheet

Assets/Liabilities	Description
Cash and balances with central bank	Include holdings of highly liquid assets, such as bank notes, gold coin and bullion, as well as deposits with central bank.
Deposits	Constitute the largest portion of a bank‟s total liabilities. Represents money accepted from the general public such as demands and savings, fixed, notice and foreign currency deposits.
Loans and advances to customers	These include loans for general working capital (overdrafts), investment lending, asset-backed instalment and mortgage loans, financing of debtors (account receivables and credit card accounts), and tradable debts such as acceptances and commercial paper.
Interbank funding	Amounts due to other banks and credit institutions, encompassing all deposits, loans and advances extended between banks that are normally regarded as volatile sources of funding. These include investment and trading securities, i.e. interest-bearing securities and equity investments in subsidiaries, associates, and other listed and unlisted entities.
Repurchase agreements	Instead of resorting to direct borrowing, a bank may sell and simultaneously agree to repurchase assets at a specific time or after certain conditions have been met. Bank securities and loans are often sold under repurchase agreements to generate temporary working funds.
Liquid assets	Assets which are easily liquidated into cash, bearing little or no interest but which are needed to accommodate expected and unexpected balance sheet fluctuations.

Borrowing from the central bank	The most frequent reason for borrowing from the central bank is that changes have occurred in the volume of required reserves as a result of fluctuations in deposits.
Fixed assets	Represent the bank‟s infrastructural resources, such as the premises from which the bank operates, other fixed asset property, computers, equipment, vehicles, furniture and fixtures.
Capital	Common stock, retained earnings, and perpetual preferred stock

Source: Adopted from Greuning H.V. and Bratonovic S.B. (1999), Analysing Banking Risk: A Framework for Assessing Corporate Governance and Financial Risk Management, Washington D.C: The World Bank.

From an overall perspective, an Islamic banking balance sheet looks very similar to a conventional one – especially the way in which the assets and liabilities sides of both are matched. As shown in Table 2.5 with balance sheet item to include the bank‟s asset side includes portfolios of financial assets based on relatively long-term contracts, such as car and home financing as well as the typical liability and equity examples. These are quite illiquid, in the sense that they cannot readily be converted into cash in case of need, and tend to be inflexible in terms of timing. This inflexibility exposes the bank to a wide array of risks, such as credit risk, liquidity risk, market risk and so on.

The liability side of the balance sheet is by definition (or should be) equal to the asset side. However, it is different in nature, since it consists of portfolios predominantly obtained from the public in the form of deposits. These deposits are by nature short-term contracts, meaning that customers may withdraw them virtually any time they wish, and thus are highly liquid. These portfolios on the liability side are in essence risk-free, since the bank is the only one responsible for honouring the promise to pay the money back to the customer in times of need.

One of the distinguishing features of Islamic finance is the system of Islamic certification for various contracts, also popularly known today as *Shari'ah*-compliant contracts. These contracts offer a comprehensive set of instruments for the purposes of mobilising and utilising funds with varying maturities and degrees of risk to satisfy the needs of various groups of economic agents in the company. *Shari'ah*-compliant instruments can be used to design a formal model for an Islamic bank that can perform the typical functions of resource mobilisation and intermediation.

Table 3.6 (Section 3.92, p. 167) presents the typical balance sheet items of an Islamic bank. It shows particular differences in the balance sheet items that can be found on the Islamic bank"s and are not available on the conventional bank"s balance sheets. These evident differences are also applied to interest-based financial intermediaries of the economy. The differences are the results of the governing *Shari'ah* mechanisms and its underlying contracts which also determine the slight deviation between Islamic and conventional bank operations. The *Shari'ah*-compliant contracts and instruments used by the Islamic banks explain the different relationships between the bank and its customers.

In a typical conventional balance sheet, the fiduciary responsibilities of banks represent the contractual relationship between them and their customers, based on debt or loan contracts. Thus, the banks" liabilities are relationship between depositors, who are effectively lenders, while the banks act as borrowers from these customers. On the asset side, the banks write other forms of debt or loan contracts to borrowers with varying degrees of maturities and risks.

The problem for Islamic banks is that the interest element embedded in debt instruments on both sides of conventional banks‟ balance sheets clearly violates the *Shari"ah* principle. Under the *Shari"ah*, loan contracts must always be interest free. Any additional benefit to the lender in a loan contract, whether monetary or in kind, is deemed as a form of *riba*, which is prohibited in the *Shari"ah*. This prohibition is evidenced in many verses of the *Qur"an*, as well as in the saying of the Prophet (*s.a.w.*). Thus the stipulation of an excess for the lender in any loan contract is clearly prohibited, as it is tantamount to *riba*, whether that excess is in terms of quality or quantity or is tangible or some other kind of benefit; and also whether that excess is stipulated at the time of the contract or while determining the period of delay for satisfaction or during the period of delay; and, finally, whether the stipulation is in writing or is part of customary practice. The principle in verses 2:278 and 2:279 of the *Qur"an* is that, in giving a loan, the creditor has the right to the principal amount only. Any amount, big or small, over and above the principal of the loan or debt would be *riba*.

Below are some specific quotations from the *Qur"an* and *Hadith* of the Prophet (*s.a.w.*) in support of the above:

***Qur'anic* Justification**

> *"O" you who believe! Be afraid of Allah and give up what remains (due to you) from Riba (usury) (from now onward) if you are (really) believers. And if you do not do it, then take a notice of war from Allah and His Messenger (s.a.w.) but if you repent, you shall have your capital sums (principal amount). Deal not unjustly (by asking more than your capital sums), and you shall not be dealt with unjustly (by receiving less than your capital sums)"*

(*Qur"an* 2:27 8-279)

Hadith **justification**

"All form of benefits (to lenders) derived from loan contracts are forms of *riba*".

In order to avoid the problem of *riba*, Islamic banks use a range of instruments to perform balance sheet activities that are structured based on various *Shari'ah*-permissible contracts. These sets of contracts enable Islamic banks to offer a wide array of products and services either for fund mobilisation or fund utilisation purposes.

2.6.2.7 Analysis of BIMB's Funds Mobilisation–Liabilities Side

There is a wide array of instruments available to Islamic banks for fund mobilisation. The following describes the salient characteristics of Islamic deposits and equity. Among Islamic forms of deposits are *wadi'ah* (safekeeping), *qard'ul hassan* (benevolence loan), *mudaraba* (profit sharing), *wakalah* (agency) and *bay,al-tawarruq* (commodity *murabahah*).

Under the *wadiah* mechanism, the deposits are held as *amanah* (trust) and utilised by the bank at its own risk. The depositors are not entitled to any return since the profit or loss resulting from the investment of these funds belongs entirely to the bank. However, the bank is allowed to offer unilateral and discretionary gifts which may be commensurate with the rate of return given by conventional counterparts on interest-bearing deposits.

Another model is the *qard'ul* mechanism, in which the funds deposited in the bank are treated as a loan by the depositor. In this case, the bank has to guarantee the principal amount and not allowed to offer any return to depositors. *Mudaraba* deposits, on the other hand, are based on profit sharing between the bank acting as the entrepreneur (*Mudarib*) and depositors as the capital owner (*Rab'ul mal*). The amount deposited is not supposed to be guaranteed, but depositors are entitled to any return derived from the invested funds.

Wakalah (agency) shares similar features to *mudaraba*-type deposits, except that the bank acts as an agent which earns an up-front fee for investment activities conducted on behalf of customers. Customers have the sole right to any returns on such investment activities. However, the up-front agreement can be constructed in such a way that the bank may earn additional performance fees as a percentage of profit sharing in any amount of profit beyond a certain predetermined threshold.

Finally, a recent innovation in Islamic banking products is another form of deposit based on the principle of sale, or more specifically *bay,al-tawarruq.* With this new instrument, the bank can conveniently quote a guaranteed principal and return based on the selling price of transacted commodities between bank and customers.

The continuing sub-section 2.6.2.8 explains in detail the salient characteristics and mechanisms of different asset products offered by Islamic banks. It consists of BIMB‟s fund utilisation particularly fund allocation to the asset side of the bank‟s balance sheet.

2.6.2.8 Analysis of BIMB's Fund Utilisation–Assets Side

As noted earlier, Islamic banks can offer a wide array of *Shari'ah*-compliant financing instruments to address various needs and demands of clients, especially poorer entrepreneurs. These instruments can be broadly divided into: (1) participatory profit-loss sharing modes like *murabahah*; (2) exchange (*muawadat*) modes like *murabahah* (cost plus sale), *bai'bithaman ajil* (sales based upon future payments), capital towards financing, *bai„ al-salam* (forward sale) and *bai„ al-istisna„* (commission to manufacture sale), and *ijara* (leasing); (3) voluntary charitable contracts (*tabarru*), such as pawning contracts (*al-rahn*) and benevolence loans (*qard al-hasan*); and finally (4) hybrid modes like diminishing partnership (*musharakah mutanaqisah*) and hire purchase (*ijara thumma al-bay„*).

2.6.3 Current issues on returns generated from securities trading: The implementation of the Goods and Services Act (2014)

In its 2014 Budget Announcement, the Malaysian Government confirmed the implementation of the Goods & Services Tax ("GST") in Malaysia, replacing the existing sales tax and service tax. GST was implemented as of 1 April 2015, at a prevailing rate of 6%. GST can only be charged by businesses registered for GST in Malaysia. The Bursa Malaysia (Malaysian Stock Exchange) is one such business. With effect from 1 April 2015, Bursa Malaysia began charging GST at the standard rate of 6% (where applicable), as governed by the GST Act 2014.

"A Goods and Services Tax (GST) is a consumption tax based on the value-added concept. GST is charged on any taxable supply of goods and services made in the course or furtherance of any business by a taxable person in Malaysia. It is also charged and levied on the importation of goods and services into Malaysia. Not all goods and services will be subject to GST. Certain basic foods and amenities are free from tax, i.e. zero rated." In addition, certain aspects of the supply of goods and services, including financial and healthcare services, are similarly exempt from GST.

In Malaysia, a person who is registered under the Goods and Services Tax Act 2014 is known as a "registered person". A registered person is required to charge GST (output tax) on his taxable supply of goods and services to his customers. He is at the same time allowed to claim back input tax credit on any GST incurred (input tax) on purchases which are necessary inputs to his business.

From 1 April 2015, the Bursa Malaysia is to charge GST at 6% which is inclusive of the brokerage fee (GST Act 2014). The schedule of fees charged by the Bursa Group includes, but is not limited to as shown in Table 2.6 below.

Table 2.6: Capital Market Trading Charges by Bursa Malaysia Implementable on 1st April 2015

Comparison of minimum broking fee of RM12 and RM40 per transaction

Buying price per share (RM)	Cost of 1,000 shares (RM)	Cost per share based on 0.7% rate or minimum RM12		Cost per share based on 0.7% rate or minimum RM40	
		RM	% increase	RM	% increase
0.50	500	0.512	2.4	0.54	8.0
1.00	1,000	1.012	1.2	1.04	4.0
2.00	2,000	2.014	0.7	2.04	2.0
4.00	4,000	4.028	0.7	4.04	1.0
6.00	6,000	6.042	0.7	6.042	0.7

Source: Adopted and modified from Bursa Malaysia"s website (http://customer.bursamalaysia.com:8080/MainLR/Pages/MainScheduleOfFees.aspx)

The buying or selling of shares is an exempt supply, as set out in the Second Schedule of the Goods and Services Tax (Exempt Supply) Order 2014. However, the fees or commission charged for the supply of services relating to the buying and selling of shares, such as clearing and settlement or brokerage fees, will be subject to GST at the standard rate of 6%. As a result of the implementation of the Goods and Services Tax Act 2014, BMD Rules and BMDC Rules are to be amended to impose an obligation on relevant participants to pay GST.

2.7 Mathematical Foundations and Recent Asset Liability Model Developments: A Synthesis

This section provides readers the foundations to the model that is developed by this thesis. It begins with the historical models developed by researchers in the past since Markowitz (1952) on portfolio optimisation and asset allocation decisions. This section continues with discussions on financial modeling as the platform to provide readers the insight into the research methodologies covered in Chapter 3 on model formulation. It continued with portfolio management theories relevant to the model established by this thesis.

2.7.1 Asset Allocation Foundations

A study by Brinson, Singer and Beebower (1991) mentioned that 91.5% of the securities‟ portfolio returns variation is due asset allocation (Sharpe, 1992). The portfolio‟s performance is largely affected by factors attributing to its risk and return distribution, which is correlated with its asset allocation. According to the concept of diversification, when a portfolio consists of non-identical securities that moves in opposite directions (where returns are negatively correlated), the potential of reducing risk of losses is higher compared to portfolio with perfectly positive correlated securities (Markowitz, 1968). Therefore, risk and returns forecasts are fundamental that serve as building blocks to attain an optimal asset mix.

According to Ledoit (1995) and Best and Crauer (1991), the efficient portfolio weights can be improved while minimising the sampling error of the portfolio assets‟ means which can be done by giving more focus on the covariance matrix of the assets returns instead of the weights of these assets. Jobson and Korkie (1980) came up with a method to tackle the sampling effort in the context of efficient portfolio under the assumption of asymptotic distribution for efficient weights prediction. Although so, this method has been criticised and replaced by Ledoit (1995) who found a pro-founding technique for the sampling error reduction by placing more emphasis on the optimised covariance matrix of the assets portfolio.

2.7.2 An Overview of Financial Modeling

In order to capture and represent the characteristics of the asset liability management problem in Islamic banks, financial assets such as investments securities and its functional structure is considered in the modeling process. This process is usually in the form of calculations with inputs from the bank‟s financial statements. Results obtained from this calculation will be used as benchmarks for decision making and recommendations from the alternate decisions generated by the optimisation programme. Financial models can also be used to summarise events for decision makers. For example, a technical analyst will perform financial modeling in order to analyse the behaviour of a company‟s stock. In this process, he would take factors affecting the stock‟s performance (i.e. return) and volatility and representing this behaviour mathematically through financial modeling to allow him the methodology for further analysis on that stock in different economic settings. This section begins with various forecasting models, simulation, stochastic and deterministic models used to represent the asset liability management decisions. It continues with the relevant model adopted by the thesis, the penalty model for asset liability management optimisation problem of the Islamic bank.

2.7.2.1 Forecasting Models

One of the first pioneering works in this area was by Chan, Karceski and Lakonishok (1999). Starting with what is known one can begin to model the impact of potential decisions on the future investment portfolio of a financial institution.

Portfolio volume forecasting requires an understanding of at least the following portfolio components: the average number of projects in a particular stage per year, the average number of projects advancing to the next stage, the average number of projects terminating and starting/reactivating in a year, the average number of FTEs and other costs per project, and the typical budget for the portfolio. In such cases, the averages may be affected. To avoid this, some data may need to be excluded. On the other hand, the model can be tested by checking whether it can predict known past portfolio changes. Even if there is ample information, forecasting with averages is hampered by one fact: no one project will run through entirely on such process averages, since every project is a unique set of process cycle times. Models that employ Monte Carlo simulation can very quickly sample the entire range of possibilities and provide solutions that can be quite informative. Such models can also more readily evaluate “what if” scenarios.

2.7.2.2 Simulation Models

The simulation approach to portfolio forecasting is intimately associated with large-scale computers, and was developed concurrently with them. Basically, it involves the use of a mathematical model in which the interrelationships between variables are specified by a set of Expressions. The analyst identifies variables as being either "input" or "output" variables, although these classes are not mutually exclusive. He then assigns specified values to the input variables, executes the simulation, and observes the resulting values of the output variables. The choice and classification of variables and the specification and definition of interrelationships are a matter of judgment; and it is possible to err in the direction of either over- or under-specification. Experience and intuition are of great assistance, and it is usually necessary to refine an initial attempt at a simulation model to obtain satisfactory results. Once the model is running properly, however, it often yields valuable insights.

2.7.2.3 Stochastic Models

The aim of asset-liability management is to find the optimal investment strategy under conditions of uncertainty in both the asset and liability streams. In the past, the two sides of the balance sheet were usually dealt with separately, but simultaneous consideration of assets and liabilities can be very advantageous when these share some common risk factors.

Allocating assets in such a way that they are highly correlated with liabilities can increase returns and reduce risk. This asset liability management technique is called immunization. Developed in the late 1970‟s, it is still very popular today. Bond immunization attempts to match the interest rate sensitivity of a bond portfolio with the interest rate sensitivity of a liability stream. The resulting allocation can however only provide limited hedging against small shifts in the term structure of interest rates. This technique is a single stage model with no transaction costs, which fails to take account of the stochastic nature of interest rates.

The process of stochastic data modeling requires one to capture and observe the dynamism of the environment where an asset is held and the uncertainty inhibiting this environment, to ease investment decision making. This can be done in programming languages (codes) inputted into the computing environment by transforming the set of mathematics representations into the computer for automated data analytics. Stochastic programming is becoming more popular in finance as computing power increases.

The trade-off between risk and reward is an important consideration in asset liability management decisions. Some researches in the literature analyses involves uncertainty modeling by looking at the tail of a loss distribution are the Value-at-Risk (VaR) and the Conditional Value-at-Risk (CVaR) (Grebeck, and Rachev, 2004).

2.7.2.4 Deterministic Models: based on the portfolio selection process

The solution to practical problems is often constrained by a number of restrictions imposed on the decision variables. Constraints usually fall into one of two categories. The first category, *domain constraints* or the *Lagrange Multiplier Method*, express the domain of definition of the objective function. The second category, *preference constraints* or the *Penalty Function Method*, impose further restrictions on the solution of the problem according to knowledge at a higher level.

Many real-world decision-making problems need to achieve several objectives: minimise risks, maximise reliability, minimise deviations from desired levels, minimise costs, and so on. Which theory is best for a given problem depends on the characteristics of the parameters involved. In the case of our subject, BIMB, the model takes parameters that are represented by the deterministic nature of the balance sheet: all values are defined „as at‟ a point in time. For example, the total asset value for BIMB‟s 2012 data is taken from the bank‟s 2012 balance sheet, based on the accounting year-end figures of 31st December 2012. The same applies to values taken from the 2009 to 2013 balance sheets.

In line with the above, the sections below discuss theories relevant to the bank‟s asset and liability optimisation model; starting with constrained optimisation techniques then moving on to constrained multiple objectives, in order to show the linkages between these two (and then decisions for multiple objectives, to model the behaviour of the current optimisation problem faced by the bank). Methods for incorporating constraints by modifying unconstrained techniques fall into two groups, as shown below.

i. Constrained Optimisation: single objective

The main goal of single-objective optimisation is to find the "best" solution, which corresponds to the minimum or maximum value of a single objective function that lumps all different objectives into one. This type of optimisation is useful as a tool to provide decision-makers with insights into the nature of the problem. A multi-objective optimisation with conflicting objectives, on the other hand, has no single optimal solution.

ii. Constrained Optimisation: multiple objectives

In many cases, optimisation problems involve multiple objectives instead of a single objective. Moreover, some objectives may conflict in the optimisation problem when it comes to making alternative parameter choices. In such cases, some trade-offs between criteria are needed to ensure a satisfactory design (Steuer, Qi and Hirschberger, 2008). Multi-Objective Optimisation algorithms allow for optimisations that take into account multiple objectives simultaneously. Each objective can be a minimisation or a maximisation of an output.

The current study uses minimisation of deviations (with penalty parameters) for its asset and liability multiple objectives. The sub-section below explains how the penalty cost optimisation model was developed to suit the aim of this study.

2.8 Literature Summary and Gap Analysis

The Islamic bank asset liability managers are keen to manage *Shari'ah* compliant investment portfolio for their clients with the objective to minimise costs and maximise wealth for their investors. The investor receives these returns in accordance to *Shari'ah* permissible way of distribution. To do this, *Shari'ah* portfolio managers should single out the conventional interest based returns from *Shari'ah* compliant asset returns with care. Therefore, knowing the balance sheet structure and how these funds are channelled to the different asset classes is important. The managers should also understand the mechanisms underlying the functionality of these assets (Adebola, Wan Yusoff and Bahalan, 2011; Hassan and Machlnecht, 2011). The functionality of these assets is highly dependent on the *Shari'ah* compliant contracting nature involved. These contracts must be screened by authorised *Shari'ah* experts. The governing elements of the different *Shari'ah* contracts are the crust to the special characteristics of the financial products and services offered by Islamic banks. For instance, the Islamic banks do not permit transactions involving interest (*riba*). Most products and services on the balance sheet of the conventional banks are interest bearing.

A simple example of the interest bearing balance sheet item of the conventional bank is the corporate bonds. Issuers of this instrument have the obligation to pay either semi-annual or annual coupons (interest payments) to their bondholders. Thus, managers of the *Shari"ah* compliant portfolio must be knowledgeable and careful during investment screening and asset selection process. He must ensure that the portfolio meets *Shari"ah* requirement and standards besides maximizing returns and minimising risks. This process also involves the considerations to other factors that could have adverse impact on the performance of the portfolio. A study by Bangia, Diebold, Kronimus, Schagen and Schuermann (2002) explains clearly how probabilities can be assigned to stress tests for the likelihood of different economic outcomes on credit performances. These economic differences affect the credit ratings of the borrowers listed on a bank"s balance sheet. Although so, the methodology is beyond the scope of this thesis. This thesis proposes in subsequent sections the benefits of incorporating stress testing with probabilities in asset liability management optimisation models for a holistic risk management in future studies.

Islamic portfolio management and screening process is somewhat different from the conventional portfolio management. Marzban (2011) in Hassan and Machlnecht (Eds., p. 402) suggests that there are three stages involved in the process of *Shari"ah* portfolio management: (1) planning (Investment policy analysis and financial analysis), (2) implementation (portfolio construction with Islamic considerations) and (3) controlling. This thesis proposes a framework that follows all the three processes above through customised methodologies (algorithms) and processes framed according to the financial model developed with mathematic representations as criteria to these algorithms for an efficient portfolio strategy.

The remaining part of this sub-section provides a comprehensive yet sufficient coverage of literatures related to the primary objective of the thesis. The discussion of this sub-section revolves around strategies taken to achieve the research objectives mentioned earlier[22]. Main financial modeling concepts will be covered to explain the stages for a model"s development and processes undertaken according to the algorithms designed to guide the fulfilment of constraints and objective functions within the multi-objective asset liability optimisation problem. The objective functions should be structured with mathematic representations to allow performance measurement and quantification. This section covers in detail the gap analysed in Section 2.10 earlier on theoretical evolution of the multi-objective model. The discussion will be based on the augmented table based on literature synthesis for linkages to this work, the flexibility of the algorithm or model used for replications, justifications to techniques used and parts if not all, of the algorithms and/or model taken as fundamental to this multi-objective asset liability optimisation model.

The analysis begins with asset liability models applicable to insurance companies around the world such as the Japanese insurance company, The Yasuda Fire and Marine Insurance Co. and Frank Russell. The differences in industrial characteristics which shaped the operating structure and asset liability needs limited the capacity with which the models or algorithms alike for replication. Similar processes or part of the stages of algorithms which could be taken for replication particularly convergence criteria for models is adopted as baseline reference criteria for this work.

Next, the analysis was performed on asset liability management models and similar algorithms adopted by the commercial (interest-bearing) banks. Since most assets and liabilities (if not all) transactions involve interest rates (*riba*) either in the

[22] See Section 1.4 on page 13.

form of returns or costs, only part of the multi-objective models were referred. This analysis provided insights for the design of the thesis‟ algorithm such as stages suggesting when the iteration process should be repeated for the best optimal solutions when convergence criteria of the multi-objective asset liability management model are not met. Examples of institutions taken as the models‟ validation studied are such as the Bank of Canada, Federal Reserve Bank of New York, Bank of Netherlands and so on. The following analysis was performed on Dembo‟s (1991) work. The author developed the stochastic and random scenarios on the asset liability management model applicable to the thermal generating system in Ontario, Canada. This study was not replicated because of the difference in industrial characteristics between the thermal generating industry (highly monopolistic) and the *Shari'ah* compliant Islamic bank. This difference alone constitutes to the contrasting characteristics and structure of assets and liabilities held on the balance sheets of these industries.

Following the analysis on the asset liability management model for thermal generating plant is the pension fund institution. Many studies on the development of asset liability management model were carried out for this industry. For example, some studies were conducted to develop and design algorithms and asset liability optimisation models for a Dutch pension fund institution, Czech Pension Fund, Finnish Pension Company, Pension Benefit Guarantee Corporation (PBGC) and many more. These companies were taken as the model‟s validation and benchmark to similar studies in the future. There isn‟t opportunity for this study to replicate or adopt part or all designs of these models. The study can neither adopt the algorithms nor the model developed for the pension fund industry because of data collection challenges faced during the data sampling process. We use the economics concept to justify this argument. High quality disclosures promote transparency which leads to competitive pressures. Mandatory disclosures enhance this objective of better disclosures which places pressures on competitions among the members of an industry. Board (2009) wrote a paper testing this concept in "Competition and Disclosure"[23].

We observe that throughout the analysis of models used or research conducted by Islamic banks especially the design of research, methodologies, processes, techniques used by previous researches share common characteristics. These studies are performed on economic concepts and analysis such as Belouafi, 1993, Bidabad, 2013, Bidabad and Allahyarifard, 2008, Chakraborty and Mohapatra, 2009, Jain and Gupta, 2004, Karim and Zahisyam, 2017, Othman, 2017, Saeed and Izzeldin, 2016, Sun, Hassan, Hassan and Ramadilli, 2014, Usman and Tasmin, 2016, Waemustafa and Sukri, 2015 and so on. On the other continuum, we also observed clearly that there are somewhat limited studies conducted in the field of computational mathematics to model specifically the asset liability management problems unique to Islamic banks. With studies across all ranges, from data envelopment analysis to measure the Islamic bank‟s efficiency in managing assets and liabilities (Sun, Hassan, Hassan, and Ramadilli, 2014) to a single objective asset liability management modeling with fuzzy analytical hierarchy components for parameters used in Belouafi‟s (1993) study.

This literature study and gap analysis provides a motivating reason for the conduct of this research. There is a crucial need for a sound risk management system to prevent the recurrence of financial crisis. This objective is important to promote the Malaysian economic growth while maintaining the security of the treasury functions of these banks. Hence, a robust asset liability management is essential not only to conventional but also Islamic banks to heighten and promote effective risk management for the industry‟s treasury function.

The asset liability management is an important tool to achieve risk reduction and profit optimisation. Mentioned earlier, the focal point of this research is

[23] See Board, O. (2009) Competition and Disclosure. *The Journal of Industrial Economics*, 57(1), 197-213.

to develop a multi-objective asset liability management optimisation model customised to suit the operating environment of the Islamic bank. This motivation is crystal clear after much analysis on literatures relating to models developed for the *Shari"ah* complying bank. This research models regulatory and religious compliances alongside with the specific risks and return objectives for the Islamic banks. It begins by mapping these requirements with reference to baseline models using penalty methods. Section 2.9 below discusses briefly the fundamentals of the penalty methods and models including asset liability problem definition (Section 2.6.1), the process of actual and target gap minimisation, constraints development and methods associated to the model"s development all under Sections 2.11.

2.9 Penalty Method

In summary, the model used in this study presumes that management aspire to maximise returns (profits) over a single-year planning horizon. This was done to simplify and reduce the dynamics to just one single period. Structural elements of the model"s mathematical formulation are detailed in later sections: Section 3.10.1 focuses on the model"s objective function, while Section 3.10.2 looks at its constraint functions.

In order to solve constrained optimisation problems, we used the penalty cost optimisation method. This involves applying a group of algorithms to the constrained optimisation problems. It begins by replacing constrained functions with unconstrained problems that ideally will converge to show the solutions for the original constraints. In this approach, the unconstrained problems are progressively added, and are known as the penalty function (as discussed in Chapter 4).

In general, the penalty function approach works as follows. Given an optimisation problem, the following is the most general formulation of constraints:

Lagrangian relaxation method (Avriel 1976, Fisher 1981, Reeves 1993) is a variation on the increase the income of banks excluding the expected coast associated with infeasibility. The penalized objective function is then the un-penalized objective function plus a penalty (for a minimisation problem). A variation on this is to construct a simple penalty function as a function of the number of constraints violated where there are multiple constraints. The penalty function for a problem with m constraints would then be (for a minimisation problem): $f_p(x)$ as the penalized objective function, $f(x)$ as the objective function without penalty parameters assigned to this function, and Ci as a constant imposed for violations of constraint i. This type of penalty function is based only on the number of constraints violated, and is generally inferior to a second approach, which is based on some distance metric from the feasible region (Goldberg and Parthasarathy, 1989; Richardson and Senge, 1989).).

In the penalty cost optimisation method, there are three exterior functions (Schwefel, 1995; p. 16). These are „evolution and optimum seeking", so that the optimal solutions lie on the boundary between feasibility and infeasibility. In line with this, a penalty is applied to feasible solutions when the constraint is not active – so-called "interior solutions." For a single constraint, this approach is straightforward (although it has not featured in evolutionary computation literature). However, for the more common case of multiple constraints, the implementation of interior penalty functions is considerably more complex. Three degrees of exterior penalty functions exist: (1) barrier methods in which no infeasible solution is considered; (2) partial penalty functions in which a penalty is applied near the feasibility boundary; and (3) global penalty functions which are applied throughout the infeasible region (Schwefel 1995, p. 16).

With reference to the optimisation objective of this study (the constrained optimisation of the balance sheet management of BIMB), all decisions made are confined economically, either socially or in terms of economic restrictions (i.e. funds and resource availability). Most economic decisions like the case problem of BIMB Malaysia asset liability decision optimisation is subject to a set of constraints unique to the operating environment of that bank.

The constrained environment usually takes a uniform processes with the following form (see Expression 3.6 of Chapter 3) with reference to Chong and Zak (2013, pp.183-186). Besides this form of penalty optimisation there are stochastic constraints optimisation and the equality and inequality optimisation problems. Usually, equality and inequality optimisation problems require a researcher to solve the optimisation problem separately. The following refers to a general form of mathematics representations of the equality and inequality optimisation, using codes within the MATLAB computing environment;

$$\min_{x} f(x) \text{ such that } \begin{cases} c(x) \leq 0 \\ ceq(x) = 0 \\ A \cdot x \leq b \\ Aeq \cdot x = beq \\ lb \leq x \leq ub, \end{cases} \tag{2.1}$$

Notice that the present study uses simulated codes from Expression 2.10 with BIMB‟s financial in year 2012 and 2013, taken as the model‟s validation. This representation is the modification of the model (under a constrained environment by Chong and Zak (2013, pp. 445–453)). The *ceq* refers to input vectors from the constrained functions, and *beq* refers to vectors of inputs from the equality constraints whereas *Aeq* refers to inputs from the objective functions of the optimisation model. The model is also subjected to the local solution of lower and upper boundaries, the *lb* and *ub* boundaries shown in Expression 2.1. Similarly, Figure 3.5 in Chapter 3 represents an evolution of Expression 2.1 in this case.

The following section is designed to encompass discussions on the current literatures by their baseline concepts starting with portfolio optimisation theories that are rooted deeply in dialogues of most papers from similar fields. The portfolio theory introduced a renowned Nobel Prize winner, Harry Markowitz (1952) in his seminary paper that proposes a way to achieve optimality by considering the risk-return trade-off factors.

The optimum asset liability portfolio can be attained by considering the broad spectrum of managerial decisions from strategic planning and implementation to operational management and control. All factors affecting the investment volume (the frequency of trading activities), balance sheet mix (combination of the different asset classes, capital structure and modes of financing), maturity of the financial instruments, market volatility of the financial instruments, profit rate sensitivity, consumer preferences for the types of *Shari'ah* based financial products and so on must be considered in asset liability decisions. For example, to the liquidity risk manager (treasurer) has to make prompt financial decisions involving asset trades to avoid against unfavourable market movements in order to prevent investment losses due to these adverse movements. A wholesome asset liability management requires the treasurer to harness the depth, breath and market resilience to obtain the lowest cost for any financial trade transaction (Pervez, 2000). This includes deposit taking by the Islamic banks. The challenge is to find the best mix between returns generated from the financial assets while taking deposits which incur various business costs. This category of financing (source of money) should be managed with care to reduce business costs (cost of maintaining deposits, cost of facility maintenance such as the automated teller machines, staff and administration costs, investment costs and so on) while having these deposit instruments packaged attractively to the market. Besides these costs, the bank should also ensure that promotion and marketing costs are adequate to create awareness and to educate consumers on Islamic financial products and services. Meanwhile, the bank should prioritise the customer‟s needs in this process.

Managing resources (asset) and obligations arising from liabilities including debt covenants and administration are equally important to Islamic banks. From the literature we observed that Islamic banks face not only greater need for investments in promotional and marketing activities for their products and services[24], they also face higher liquidity risk than their conventional interest-based banks. The lack of awareness and understanding among consumers for Islamic financial products and services leads to less liquid Islamic financial market and therefore causing lower market demand and supply (Abdul-Rahman, 1999). Hence, Islamic banks hold less liquid resources which do not match with their highly liquid liabilities like the various types of demand deposits offered. Given the slight difference in Islamic bank‟s balance sheet structure and the need to comply with *Shari'ah* rules and governance, the bank shall not hold any speculative (*takhamiyn*) financial instruments and is not permitted to be involved in dealings which could give rise to gambling (*maysir*) and financial instruments high level of uncertainties (*gharar*) such as the financial derivatives offered by conventional financial institutions (i.e. swaps, options, forward, futures, warrants and so on).

The bulk of these challenges mentioned above lie in the art of asset liability management. Analysis on recent literatures suggests that there is limited research in the area contributing to the development of Islamic asset liability

[24] See Metawa, S. A., & Almossawi, M. (1998). Banking behavior of Islamic bank customers: perspectives and implications. *International Journal of Bank Marketing*, *16*(7), 299-313.

management models. Most studies are confined to performance comparisons between the conventional and Islamic banks in terms of liquidity, profitability, solvency, resources and operational efficiency (Chakraborty and Mohapatra, 2009; Karim and Zahisyam, 2017; Othman, 2017; Saeed and Izzledin, 2016; Waemustafa and Sukri, 2015; Sun, Hassan, Hassan and Ramadilli, 2014; Usman and Tasmin, 2016[25] and so on).

It is therefore significant to have the need for an evolved model with analogy based on mathematic propositions and foundations customised to suit the asset liability management environment of the Islamic bank. This emphasis is based clearly on the unique balance sheet problems (See Section 2.6 in Chapter 2) faced by the Islamic banks which leads to slight differences in approaches taken for the bank‟s asset liability management. Current conventional baseline models developed for conventional banks can be found in the studies by Kusy and Ziemba (1986) for Vancouver City Savings Credit Union for a five year planning period, the Rusell Yasuda-Kasai model by Carino *et al.* (1994) for a Japanese insurance company with reference to stochastic characteristics of the annual interest on savings for years 1991 and 1992, scenario optimisation model by Dembo (1991) for a hydro-thermal plant‟s portfolio optimisation, Mulvey and Vladamirou (1992) with their customised stochastic network programming for financial planning problem as well as other baseline conventional, non-*Shari'ah* compliant models. A detailed observation and analysis in Section 2.10 gives us a brief insight about the limited approach or initiatives taken to develop a customised model for the Islamic bank asset liability management environment.

Summarising the above, the thesis took a step further to bridge the literature gap by having a customised-multi-objective asset liability management model for Islamic bank using the financial modeling technique, an approach that is found

[25] The detailed analyses of these literatures are covered in Section 2.10.

limited within the literatures of Islamic financial studies. The study adopts exceptionally BIMB"s financial statements to validate the model. The model is flexible for future replications and improvements. The following section clarifies with detailed discussions of studies alike in the past to clear the paths to the knowledge gap that this study ratifies. The information in Section 2.12 is necessary to furnish relevant information needed for the gaps, rationality for this study and methodology and methods of the thesis. Justifications and motivations for the three main research objectives in Section 1.6 are scrutinised in this section.

2.10 A General View on the Literatures: Optimisation Models

Portfolio management involves decisions about the allocation of resources between competing choices, with usually undetermined outcomes (Padalos, Sandstorm and Zopounidis, 1994; Sharpe, William, Alexander, and Bailey, 1999). Harry Markowitz kick-started the ideology of portfolio allocation based on mean-variance analysis with his seminal papers of 1952 and 1959 (Mansini, Ogryczak and Speranza, 2015; Markowitz, 1952). He posited that the key issue is investors" expectations on returns, and their tolerance for any deviation from expected outcomes (Markowitz, 1952; Ziemba and Vickson, 2014). Markowitz therefore advocated maximizing the expected investment returns, while at the same time searching for assets that are not too closely correlated with one another so as to reduce risk. A portfolio is commonly represented by n number of securities. The key decision is how to allocate the right, efficient amount to each investment. Short-selling is usually disallowed in such circumstances, to avoid complicated computations.

Starting from this legendary finding, further research has continued to build new paradigms with the objective of obtaining the most efficient portfolio management. Some of the main elements and developments in this area are discussed in the sections that follow. The next section, Section 2.11 covers central portfolio management theories in depth. This section discusses all portfolio management models including forecasting models, simulation models, and other mathematical models in modern portfolio management concepts. The preceding sections include discussions on models used for portfolio selection process. The sub-section is followed by discussions of the single objective models, and theories of multiple objective portfolio management. Theories relevant to linear and multiple objective programming were discussed after discussions about components forming both the single and multiple objective portfolio optimisation models.

2.11 Portfolio Management Strategies and Theories

A key element of portfolio investment strategies is asset allocation: the process of allocating capital to various kinds of assets to achieve certain goals. These goals may be to maximise returns and increase the value of capital invested, to preserve the value of capital, and/or to finance future liabilities or living standards. These choices are made by investors, and are constrained by their own appetites for risk, liquidity needs, tax and legal considerations. These priorities are normally spelt out in detail by an investor in what is known as an Investment Policy Statement, which serves as a blueprint for wealth managers engaged in investing funds for customers.

Asset allocation strategies can be classified into various categories, but can generally be summed up as either passive or active. Passive strategies tend to be more long term and can follow the market using indexing as an approach. Investors may opt for buy and hold strategies or asset mix strategies. The general principle is not to react to short-term market fluctuations, but to invest in assets based on fundamentals in the expectation of long-term returns as asset diversification and time diversification even out short-term fluctuations. While passive investors will, as described, tend to focus more on long-term expectations of how an asset class is likely to perform, they may also from time to time react in a limited manner to short-term changes in the markets.

Active strategies, on the other hand, are generally shorter-term in nature, reacting to short-term market fluctuations so as to benefit from short-term movements in asset prices. Active investors constantly observe market expectations, and try to pre-empt the market by purchasing assets before the market recognises any arbitrage opportunities or before the market price fully reflects the value of an asset. These types of strategies bear larger transaction costs, as investors may execute several trades in a day.

In line with the above, in an interview in February 2014 the chairperson of the Saturna Fund management company strongly supported the buy-and-hold portfolio management philosophy. This strategy is more conservative than active portfolio management strategies, which involve the aggressive trading of growth stocks, thus entailing higher risks. Buy-and-hold investment, on the other hand, commits fund managers for a longer term. Research has shown that portfolio managers commonly underperform compared to passive investment strategies, because active investment strategies mean more trading activities and, as Saturna‟s chairman put it, more trading exposes the company to higher risks as well as entailing higher costs for transactions. This was borne out by a 2014 paper by Chong, Ng and Muhamad (2014), in which they analysed the performance of general stocks in Malaysia, Hong Kong, Singapore and Korea for the period from 1990 to 2009 and found that a buy-and-hold investment strategy generally brought higher returns.

Given the generally less aggressive nature of *Shariʻah*-compliant fund managers, a more conservative approach as reflected in the findings of Chong, Ng and Muhamad‟s (2014) paper above would seem appropriate for asset allocation recommendations for BIMB. Accordingly, justifications from this paper are used to assist and support the asset allocations generated by the optimisation model. In Islamic banking perspective, Dow Jones Islamic indexes and conventional index claims same diversification benefits (Hassan and Girard, 2010). The growing complexity of portfolio managing environment (in this context, we refer to the balance sheet, asset liability portfolios of the Islamic banking industry) assets and liabilities reporting structure, financial innovations and so on placed tremendous pressures and challenges in managing huge and sophisticated portfolios. These challenges gave rise to updates and development in finance theories and concepts known as modern finance.

Modern finance theories are based upon traditional financial economics mathematical finance (Jovanovic and Schinckus, 2013a; Jovanovic & Schinckus, 2013b). The need to find methods to optimize portfolio management arises from the mathematical complexity necessary to describe the theory of systems, processes, equipment, and devices which are involved. For many reasons, any theory is by definition imperfect (Beckman and Chen, 2015), yet it must be used to predict the optimum operating conditions of a system in a way that satisfies certain performance criteria. At best, such theories can predict only that the system is near to the desired optimum. Further optimisation methods are then used to analyse in more detail the local region in which the theory is operating and predict how the system parameters should be adjusted to bring the system to its optimum point (Adby, 2013; Ziemba and Ziemba, 2013).

In an industrial process, for example, the criterion for optimum operation is often minimum cost (Kirk, 2012), where the product cost can depend on a large number of interrelated controlled parameters in the manufacturing process. In mathematical terms, the performance criterion could be, for example, to minimise the integral of the squared difference between a specified function (Haftka and Gürdal, 2012; Kirk, 2012). In addition, there may also be parameters which are not controlled but which can be measured, and possibly some which cannot even be measured.

Before the advent of high speed computers, this type of problem was insoluble for systems with a large number of parameters. Human judgement alone is often unable to optimise systems with even as few as three variables (Haftka and Gürdal, 2012). The use of computers has however led to the widespread development and use of the theory of optimisation, and a number of algorithms are now available that are capable of handling systems of more than one hundred variables. In some cases, particularly for linear performance criteria, even much larger problems can be solved (Resende and de Sousa, 2013). The key to optimisation lies not in trying to find out all about a system but in finding out, with the least possible effort, the best way to adjust the system. If this is done well, it can lead to systems with a more economic, improved design (Resende and de Sousa, 2013); to systems that can operate more accurately or at less cost (Kyngäs, Nurmi, and Kyngäs, 2012); and to ones where the system designer has a better understanding of the effects of parameter interactions and variations on the design.

The remaining sections of this chapter provide an introduction to theories supporting the development of the optimisation model to be used in this study (Kyngäs, Nurmi, and Kyngäs, 2012; Resende and de Sousa, 2013). Preliminary models discussed in the following sections (Section 2.11.1: Problem definition and its preceding sections) are directed to brief readers on how the evolvement of the penalty optimisation function is important to the foundation to models alike. This foundation is crucial to provide readers the baseline understanding on how other models in the literature is developed and improvised[26].

Methods of financial modeling are covered briefly in Section 3.9 and Section 3.10, with illustrations of processes undertaken in the mathematical environment shown by a set of decisions support diagram in the form of algorithms. In depth explanations on the workability and functions of this set of algorithms are also covered in Section 3.11 (Refer Figure 3.4 and 3.5). The rest of this chapter focuses on theoretical aspects of optimisation and how this model is customised to the asset liability management environment (needs and compliances) of BIMB as the prototype or model‟s test. Chapter 3, the methodology chapter of the thesis details the modifications to previous Islamic asset liability management models found in the literature.

2.11.1 Portfolio Management Problem Definition

Preceding subsections explain the mathematic problems and foundations related to asset liability portfolio optimisation problems. It begins with the concept of minimisation, a concavity of the optimisation problem, the local and global minima as the solution point to the optimisation problem, how this can be achieved with the concept of gradients, and constraints limiting the number of solutions suggested for an optimisation problem.

[26] See Section 2.8 (p. 104) of the thesis for comparisons and improvements taken by this thesis.

2.11.1.1 Minimisation

The basic mathematical optimisation problem is to minimise a scalar quantity *E,* which is the value of function *n* system parameters $(x_1, x_2, \cdots, x_n)$. These variables must be adjusted to obtain the minimum required (Ziemba and Vickson, 2014), i.e. to

$$minimize\ E = f(x_1, x_2, \cdots, x_n). \tag{2.2}$$

The minimisation problem is formulated here as a minimisation problem of BIMB"s objective function (goal deviations between actual and targets). This is not restrictive since almost all problems can be put in this form. In particular, a maximum of a function can be determined by a minimisation method since

$$maximum f(x) \ = — minimum\,\{-f(x)\} \tag{2.3}$$

The value *E* off embodies the design criteria of the system into a single number, which is often a measure of the difference between the required performance and the actual performance obtained (Mansini and Ogryczak, and Speranza, 2015; Ziemba and Vickson, 2014). The function f is referred to as the objective function, whose value is the quantity which is to be minimised. The *n* system parameters will be manipulated as the column vector *x*. The transpose of *x* is given in matrix form by

$$x^T \ = \ [x_1, x_2, \ldots, x_n] \tag{2.4}$$

Where; *T* signifies the transpose of a matrix. In this work, the co-ordinates of x will take successive values as adjustments are made to their values during the optimisation process. Each set of adjustments to these variables is termed an *iteration* (Mansini, Ogryczak, and Speranza, 2015; Ziemba and Vickson, 2014). In general, a number of iterations are required before an optimum can be obtained. After i iterations, the value of E will be given by E_i, and the value of x will be x_i. In the iterative processes or algorithms to be studied, a first estimate of the parameter values must be supplied as a starting point for the search for the minimum. Since at that stage no iterations have taken place, the first estimate of x will be denoted by x_0, and the resulting objective function value will be E_0. The final optimal values obtained will usually be denoted by x_{min} and E_{min} respectively. Changes in the parameter values will be denoted by the vector Δx. Its transpose is given by

$$\Delta x_T = [\Delta x_1, \Delta x_2, \cdots, \Delta x_n] \tag{2.5}$$

2.11.1.2 Local and Global Minima

Floudas *et al.* (2013) wrote a comprehensive academic reference on the subject of local and global minima test problems for various optimisation problems. The determination of the parameters x_{min}which give a minimum value E_{min} of the objective function f is the object of the optimisation. E_{min} is the lowest possible value of E for any combinations of values of the variable x. A pointx_{min}, which gives the lowest possible value of f, is termed a *global minimum* (Floudas *et al.*, 2013, p. 15). This need not be unique. In practice, it is very difficult to determine if the minimum obtained by a numerical process is a global minimum or not (Floudas *et al.*, 2013, p. 89). In most circumstances, it can only be said that the minimum obtained is a minimum within a local area of search (p. 98). (For simplicity we are here ignoring the problem of limits to numerical accuracy.) The point x_{min} is therefore termed a local minimum. Again, it need not be unique even locally, but since a given convergent numerical process implemented on a particular computer should always converge to the same point from a given initial value x_0, the local minimum will be referred to throughout this study as the minimum without confusion or essential loss of generality. A particular function may, of course, possess several local minima. One of these will also be the global minimum, but it is usually impossible to determine if a local minimum is also the global minimum unless all minima are found and evaluated (Floudas *et al.*, 2013, p. 178).

2.11.1.3 Gradients

Some optimisation methods require gradient information about the objective function given by $E = f(x)$. This is obtained in the form of first and second order partial derivatives of f with respect to n parameters. The *Jacobian gradient vector* g is defined as the transpose of the gradient vector ∇f which is a row matrix of first order partial derivatives. This approach is also described by the Newton-Raphson method, using the first-order differential of $y=f(x)$ (Leggett, 2013, p. 5). The transpose of g is therefore given by

$$g^T = \nabla f = \left[\frac{\partial f}{\partial x_1}, \frac{\partial f}{\partial x_2}, \cdots, \frac{\partial f}{\partial x_n}\right] \tag{2.6}$$

The $n \times n$ symmetric matrix of second order partial derivatives of f is known as the *Hessian matrix* and is denoted by ***H***, where

$$
\boldsymbol{H} = \begin{bmatrix} \frac{\partial^2 f}{\partial f^2} & \frac{\partial^2 f}{\partial x_1 \partial x_2} & \cdots & \frac{\partial^2 f}{\partial x_1 \partial x_n} \\ \frac{\partial^2 f}{\partial x_2 \partial x_1} & & & \vdots \\ \vdots & & & \\ \frac{\partial^2 f}{\partial x_n \partial x_1} & \cdots & \cdots & \frac{\partial^2 f}{\partial x_n^2} \end{bmatrix} \tag{2.7}
$$

The availability of the *Jacobian* vector and *Hessian matrix* (Leggett, 2013, p. 8) simplifies optimisation procedures, and can sometimes allow problems with a larger number of variables to be solved. However, it is usually necessary for more general methods of optimisation to proceed without gradient information, since derivatives may be uneconomic or impossible to compute, and in some cases may not even exist (Leggett, 2013, p. 166).

2.11.1.4 Constraints

In many practical optimisation problems there are constraints on the values of some parameters which restrict the region of search for the minimum. Pagnoncelli, Reich and Campi (2012) wrote an article summarizing multiple constraint methods for portfolio optimisation, based on the problem of risk-return trade-offs under different scenarios, with specific case studies included to show the application of the above concept. Readers wishing to know more about this aspect should refer to their work.

Under multiple constraint optimisation, the common constraint on the variable x_i is in the form of the inequality $x_{L,i} \leq x_i \leq x_{U,i}$, where $x_{L,i}$ and $x_{U,i}$ are fixed lower and upper limits to x_i. More generally, „inequality constraints" are formulated to specify functional relationships between the parameters involved in the constraint. Most inequality constraints can be fitted into the form

$$g(x_1, x_2, \cdots, x_n) \le 0$$

For the simple case of upper and lower limits, the expression $x_{L,i} \le x_i \le x_{U,i}$ is replaced by the two expressions

$$x_i - x_{U,i} \le 0$$
$$x_{L,i} - x_i \le 0 \qquad (2.8)$$

The region of search in which the constraints are satisfied is termed the *feasible* region, while the region in which constraints are not satisfied is termed the *non-feasible* or *infeasible* region (Antoniou and Lu, 2007). It is also possible to optimise systems in which the parameters are constrained to specific functional relationships. This type of constraint can be formulated in a similar way to inequality constraints and then Expressions of the form are obtained. Optimisation with constraints is very much more difficult than unconstrained optimisation, and a great deal of effort is therefore often expended to reformulate constrained problems so that constraints are avoided (Antoniou and Lu, 2007). For this reason, constrained optimisation is not considered until the final chapter of this study.

$$h(x_1, x_2, \cdots, x_n) = 0 \qquad (2.9)$$

2.12 Concluding Remarks

In summary, our asset and liability management model has been developed based on the various requirements of BIMB internal and external operating factors.

Internal factors include internal requirements within the bank, such as solvency management policies, profitability objectives, giving to society to fulfil religious objectives, and so on. As vicegerents accountable to God, Islamic banks try to operate within *Shari'ah* principles while at the same time doing good deeds to humanity (through economic or *Muamalat* objectives).

External factors include requirements deriving from laws and regulations, such as capital requirements under Basel III and reporting requirements (when there is certain reporting requirement, the Islamic bank is forced to fulfil and disclose all necessary compliances based on these requirements). As mentioned in earlier sections, such requirements can derive from *Shari'ah* principles, like not holding more than certain percentages of liquid assets, receivables or debt as ratios to total assets.

These internal and external factors can interact and impact on each other, and cannot therefore be managed in isolation. For example, market rate risks could affect the ability of BIMB to generate income. In turn, BIMB could face liquidity problems such as having insufficient revenue for debt repayments or returns to *mudaraba* or *musharakah* depositors. The first scenario above could lead to solvency problems, while the second points up unique risks that Islamic banks face when seeking to match the competitive rates offered by their conventional interest-based banking competitors. This idea of addressing multiple objectives (targets) in a management model is one of the things that make this research innovative and original, as there has to our knowledge not been any previous research focusing on this.

Next, this thesis aims to provide a basis for understanding current issues in Islamic bank asset and liability management. A clear understanding of this is essential if we are to achieve effective balance sheet management which takes account of potential problems not addressed by existing models. At the same time, the model we develop has to retain various functional parts from contemporary balance sheet management approaches, upgraded with improvements to address weaknesses in the existing models.

CHAPTER 3: METHODOLOGY AND METHODS

3.1 Introduction

This chapter discusses all methodological aspects of the model‟s formulation. It begins with Section 3.2 to explain the logical empiricisms governing the fundamentals of this research. Section 3.3 includes sample data inputs used for analyses and the development of the asset liability multi-objective optimisation model. Convergence theorem as the model‟s validation criteria is covered in Section 3.4. Reasons for the non-application of the interest returns from investment over a chosen investment period and the appropriate discount factor considered in Islamic finance for this research is also covered in this section. Approaches used for data processing is detailed in Section 3.7. Multiple objectives optimisation and the model‟s development are contained in Sections 3.8, 3.9 and 3.10. Algorithms and concepts used to guide programming for the optimisation problem is in Section 3.11. Justifications enabling the model‟s functionality are discussed in sections 3.12 and 3.13. The chapter concludes with remarks in Section 3.14.

3.2 Research Philosophy and Research Design

Bailer-Jones (2009) reviewed philosophical writings of famous studies from different field of sciences especially in processes involving knowledge development. Factors analysed by the author are mechanisms, analogies, theories, metaphors and paradigms, phenomena and representations in treating scientific models. In a similar way, Knuuttila, (2011) added that that a model is an interpretive description of a phenomenon that facilitates access to that phenomenon. Bailer-Jones (2009), Chaturvedi (2010), Knuuttila (2011), and other renowned philosophers in mathematics, theory building, mathematic and its role in modeling shared the same ideology that a phenomenon can be represented by things happening or occurring within the system. This system may be represented by different fields of interests a scientist or researcher explores/ investigates (Bailer-Jones, 2009, p. 7). The approach documented by the author has been in existence since the emergence of famous philosophers and the civilisation in thinking and learning processes for knowledge evolution. It begins with the era of metaphysical knowledge birth imaged by Socrates, Aristotle, Plato and other great ancient philosophers (Russell, 2013) that marked the ontological development of insights and epistemological evolution in knowledge and ideas that are based on logical empiricism in philosophy of sciences (Bailer-Jones, 2009, p. 16). Mittelstrass, (2012, November; 2014) a renowned German philosopher wrote in his recent seminary paper "*Complexity, Reductionism, and Holism in Science and Philosophy of Science"* that complexity of the different areas of study depends largely on the inhomogeneity of the subject (Mittelstrass, 2012, p. 46; 2014). This inhomogeneity is observed in the operational context especially in Islamic bank asset liability management in Malaysia in comparison to conventional banks.

The higher is the complexity of a system, the stronger is the demand for dynamism and frequent interaction between numerous elements and ways to analyse that system. This discipline is usually accompanied by newer mathematical methods involving complex theories to baseline traditional fundamentals that could begin with basic to complex statistics and probability theory. The foundation of this thesis is the combination of several other methodologies laid down by philosophers in the area of mathematics in a deductive manner (Feyerabend, 1976; Lakatos, 1980; Musgrave, 1970; Popper, 1972, 2005, 2014).

The building blocks of the optimisation model development are based essentially on financial modeling techniques. Modeling improves the operational aspect of decision making through an improved set of decision aids enabling one to probe the consequences or outcomes of particular actions or phenomena in the world perceived relevant to the future of the society (Chaturvedi, 2010; Kumar and Leonard, 1988; Venkataraman, 2009). Financial modeling is the process of abstraction (using models) of the real system (Chaturvedi, 2010). In the case of this study, it involves the task of developing an abstract to represent the Islamic bank balance sheet problem. Financial models are mathematical models designed to simplify the phenomena or problems of the actual settings such as the performance of the assets and liabilities, logistics, business and projects management and investment evaluation (Shapiro, Dentcheva and Ruszczyński, 2009). A good example of models developed to aid forecasting and to promote prediction accuracy is the weather forecast model and an example from the finance field is the use of models to manage interest rate or exchange rate volatility. A good model requires accurate abstraction which should be parsimonious to encourage systematic phylogenies[27] and efficiency to promote the data processing environment (Chaturvedi, 2010). More on historical development and the emergence of financial modeling techniques is covered in Section 2.7 on "*Mathematical Foundations and Recent Asset Liability Model Developments: A synthesis*" and Section 2.7.2 "*An Overview of Financial Modeling"*. Section 3.3 covers descriptions and discussions on data used as inputs to the multi-objective asset liability optimisation model for Islamic bank.

3.3 Sample Data

In most scientific and engineering problems, the quantity to be minimised is a function not only of controlled parameters $x_1, x_2, \cdots, x_n$, but also of one

[27] A phylogeny criterion involves adaptations or artificial representations in a selection processes in establishing an acceptably reflective system of the actual context. Interested readers may refer to writings by Felsenstein and Felenstein (2004), Ronquist and Huelsenbeck (2003) and Swofford and Documentation (1991).

or more independent variables (for example, time or the position of an object). The objective function *f* then takes a series of values as the independent variables vary (Adby, 2013; Chong and Zak, 2013; Leggett and David, 2013). The physical measurement of this objective function can only be entered into a digital computer as a series of values at specific sample values of the independent variables. Here, the number of samples may be limited by either practical difficulty in making measurements or by disturbance of the system caused by the measurement device (Antoniou and Lu, 2007; Beaumont, 2004).

Similar situation exists in mathematical problems involving independent variables (for example, when optimising the choice of a function of a prescribed type to approximate a given function), since functions can only be evaluated by the computer for specific sets of values of the function arguments (Adby, 2013; Chong and Zak, 2013; Leggett and David, 2013). In practice, therefore, curve fitting and similar processes are generally handled by the use of a number of sample points sufficient to describe the graphs of the functions involved (Chong and Zak, 2013).

Many optimisation problems are therefore concerned with functions in which data is only available at a number of sample points. The number of sample points is dependent on the function and may vary from fewer than ten to several hundred number of observations (Antoniou and Lu, 2007; Beaumont, 2004). The basic optimisation problem in these cases is in a slightly different form to that stated in Equation 3.1 (hereafter will be used interchangeably with the term ***„expression'*** instead of *Equation*). The value *E* of the objective function is now a vector whose elements are *errors* at the individual sample points. All these elements must then be simultaneously minimised in the manner determined by the customised optimisation problem. If the problem is restated so that the ***individual errors of E*** are combined into one scalar quantity, standard methods of optimisation can be applied (Chong and Zak, 2013). The new objective is to minimise E, where E is a function dependent on the parameters $x_1, x_2, \cdots, x_n$, through functions of the parameters and the independent variables. Here is an example:

$$E = g\{f(x, t_1), f(x, t_2), \cdots, f(x, t_m)\} \tag{3.1}$$

Where $t_1, t_2, \cdots, t_m$ are vectors of values of the independent variables at the m sample points. The form of the function g is termed the error criterion, and is discussed in Section 3.4.1 on page 133.

3.4 The Convergence Theorem

Two problems of convergence of the iterative process of a given optimisation method arise (which is programmed for model‟s functionality/ test within the MATLAB system). Before convergence occurs, it is necessary to answer the following questions before the different techniques can be compared (Leader and Leader, 2004).

i. Has the value E of the objective function converged to a minimum, and is this minimum a *global minimum*?
ii. What was the speed of convergence?

The value of E for successive iterations will in most cases be the only available guide to the progress of minimisation (Chong and Zak, 2013; Leader and Leader, 2004). When E does not reduce over a number of iterations, progress has clearly stopped and some kind of minimum has been reached. The geometric interpretation of this will be covered throughout convergence concepts of this thesis. Sections 3.4.1 and 3.4.2 provides a foundational view of the convergence theorem as the model‟s validation method in the asset liability optimisation approach in financial modeling. In practice however, it is almost impossible to predict if the minimum reached is a global minimum. None of the iterative techniques described can guarantee convergence to the global minimum when several minima exist (Leader and Leader, 2004). Indeed, it seems unlikely that any non-linear optimisation technique can achieve this. Even extensive testing of all the minima found cannot guarantee a complete answer, since a given technique may never converge to the global minimum of certain functions.

Looking at question (ii) above, the relative speed of convergence is usually expressed in terms of the number of f functions necessary to reduce E by a specified amount, since the time required for a given computer to reach a solution is largely made up of function evaluations (Leader and Leader, 2004).

3.4.1 Error Criteria and Weights

The values of the independent variables at each of the m sample points may be incorporated into the function f of x in Expressions 3.2 to yield

$$E = g\{f_1(x), f_2(x), \cdots, f_m(x)\} \quad (3.2)$$

This is the technique of finding the local minima (See Expressions 3.1, 3.2, 3.3) as the quadratic convergence of this method to x_n. If x_0 is not close to the minimum sufficiently, the optimisation process would need to converge f to the maximum then, given the assumptions that the functions are a set of differentiable multiple number of periods/time (Leader and Leader, 2004).

3.4.2 The Least Squares

The function g is most often used in curve fitting and other applications (for example in statistics and econometrics). It is known as the least squares error criterion. The curve fitting with function g is given by Expression 3.3[28]

$$minimize\ E = \sum_{i=1}^{m} \{w_i f_i(x)\}^2 \qquad (3.3)$$

Where $w_1, w_2, \cdots, w_m$ are termed weights or penalties, and have the effect of emphasizing errors of importance in the formulation of the optimisation problem. Weights are also used in cases in which there are several independent variables, in order to equalize the effects of error when the corresponding function values $f_i(x)$ give errors on a vastly different scale as different variables vary. Leader and Leader (2004) explained convergence methods comprehensively with Newton"s method for non-linear optimisations (Leader and Leader, 2004, pp. 468 – 470)[29].

3.5 Time Value of Money and Islam

The importance of the *time value of money* in Islamic finance should be emphasised before the process of establishing the asset liability optimisation model. It regards the period when returns in the form of cash in finance should be discounted at appropriate discount factors to reflect risk undertaken in investments. This section justifies the calculations of the expected cash flows used as inputs to financial ratio calculations to assess the asset liability management performance of BIMB (i.e. quality of assets, the funding state and capitalisation) for years 2009 to 2013.

[28] See Leader and Leader (2004, pp. 468 – 470)
[29] Interested readers may get more insights from his work starting on page 73 of his reference.

The time value of money regards basic investment concepts and theories in finance. *Shari`ah* does not rule out this aspect, for it does not prohibit an increment in a loan to cover the price of a commodity in a sale contract to be paid at a future date. However, it is prohibited if a specific predetermined marginal rate is attached to a lending. *Shari`ah* requires that a loan be due in the same amount and the value of currency in which it was given. The value (i.e., purchasing power) of paper currencies can however vary due to changes in variables (like costs arising from this lending process). The *Shari"ah* law outlines further that the parties to a loan contract must not have control over the volatile factors affecting this change (Ahmad and Hassan, 2006).

The concepts above can be summarised by asking two questions relating to the structure and functioning of the Islamic banks. The first question regards whether the determinant of the price of money and credit sale of commodities for commodity-based contracts like commodity *murabaha* is *Shari"ah* permissible. The second question asked in determining whether a mark-up is usury for loans offered by Islamic bank resembles conventional interest-based lending or methods to derive at the mark-up decision is approved by the *Shari"ah* committee (Siddiqui, 2014). A transaction does not contain usury elements if the answer to the above questions is „yes".

These two questions can be the source of reference to common claims made by different scholars from various Muslim schools of thoughts to provide guidance in comprehending and understanding of arguments and conflicts in debates related Islamic financial product"s *Shari"ah* compliance. This process should not be exhaustive. Whether a financial product is *Shari"ah* compliant should also consider other *Shari"ah* principles. The law should not be viewed in isolation. It should also account for other *Shari"ah* compliant assessments and regulatory mandates by central bank.

An article by Hanif (2014) provided a clear distinction between Islamic and conventional banks. He wrote that *riba* or interest is considered usury prohibited in Islam if interest is charged on loan provisions or on top of the principal amount lent. If we include the time-based discount factor under this *time value of money* approach, we are effectively assigning an interest factor, which is the „expected‟ or „fixed‟ interest return. If this occurs, there is an interest element or fixed charges on top of capital provisions which should be considered as *riba* and is non-permissible by *Shari‟ah* (Hanif, 2014; Siddiqui, 2014).

Simplifying this notion and to avoid computational complexities, this research assumes that the expected cash flows incurred by BIMB are taken in their original form. There should be no discounting factor attached to these cash flows in the computational methodologies for this research. This *time value of money* assumption is important for the customised methodology in financial modeling of this research.

3.6 Financial Modeling: Civilisation and the Evolution in mathematics

Financial modeling processes involve the art of capturing, representing and testing a real system mathematically in a simulated computational environment without having the need for resource wastage from trials and errors arising from these processes. It was discussed briefly in Chapter One about the negative consequences of testing the impact of market rate changes to examine the performance of the actual money market portfolio. Apart from the likelihood of having potential losses if this is conducted, this act is also regarded as a form of speculation (*gharar*) in Islam due to its high level of uncertainty (*maysir*). The *Shari‟ah* law prohibits this act of speculation before any investment decision is made because this act of speculation could bring potential harm to the Islamic bank‟s solvency position. Testing the impact market fluctuation on an actual portfolio to examine the consequences of these fluctuations on the value of that portfolio in a simulated environment represented by mathematics using programming software is therefore more preferable (Chaturevedi, 2010). The portfolio manager may analyse all potential impacts under probabilistic scenario experiments within this computing environment (Beaumont, 2004; Capiński and Zastawniak, 2003; Chaturvedi, 2010; and Tjia, 2009). The research is motivated by the benefits of having a simulated environment for BIMB‟s asset liability management. Financial modeling is adopted to foster these benefits to ease worries related to unnecessary portfolio losses with experiments performed within the simulated rather than the bank‟s actual environment. To achieve this, algorithms related to the financial modeling and asset liability management optimisation is designed, established and documented to achieve Research Objective Two (2).

Some details of the concepts in financial modeling was covered in Chapter 2. This chapter continues with discussions related to functions formulation and returns calculation with reference to Expression 3.4 using monthly Islamic Money Market yields f0r year 2012 and 2013. These data is used as inputs for the optimisation model in Section 3.10.

In order to avoid high costs in data collection using stochastic multi-period data apparatus and instrumentation for data sampling from BIMB‟s treasurers and to avoid the possibilities of not meeting the planned research timeline, the research has resorted to secondary data available from the Thompson Reuter‟s DataStream and other reliable platforms for data collection. This is done with the support and justifications from previous literatures on data collection for the multi-objective asset liability management optimisation modeling. This process begins with reviews conducted on related literature starting year 2010 understand recent developments in

Islamic bank asset liability management approach. Areas concerned during this review were innovation and initiatives for Islamic bank asset liability management, methodologies and models used for the asset liability management process, emerged key areas like new capital requirements under Basel III as well as updates from the research and practicing industry on asset liability management techniques and challenges. This review is done to ensure that the model established by this research incorporates sufficiently required updates and current issues concerned by the body of knowledge in this field. In detail, the review is performed with search and analyses involving studies conducted from reliable sources of information such as literatures published in ranked journals, reports from the central bank, working papers and articles compiled by the International Monetary Fund (IMF), and BIMB"s annual reports for strategic comments by the Chief Executive Officer (CEO).

Fundamental processes developed by previous researchers using penalty cost technique like Belouafi (1993), Chong and Zak (2013), Kumar and Leonard (1988), Kusy and Ziemba (1986) were scrutinised to guide the modeling process. This approach was motivated by the study conducted by Kusy and Ziemba (1986) and Chong and Zak (2013). However, there are inherent weaknesses in their formulation. The stochastic programming method with recourse by Kusy and Ziemba (1986) although giving considerations to the timing of forecasted cash flows in their recourse model they neglected the multi-faceted desires of the managers in performing this task. Mentioned in previous sections, it is insufficient to assume only one objective in asset liability management in this complex financial environment (Kumar and Leonard, 1988).

Belouafi (1993) on the other hand focussed only on a single objective optimisation model of the asset liability management problem for Kuwait Finance House and Jordan Islamic Bank. The model was formulated based on the operating environment of one of these banks and it was made flexible for adjustments to capture unique desires, mirroring each bank‟s assets liabilities optimisation specific goals. The author performed linear programming for the two practicing institutions for periods 1989-1999 and 1987-1988 respectively.

Although the author performed intensity ranking to several goals rectified using the data collection apparatus which was designed to collect responses relating to the bank managers‟ perception on the importance of these goals, assumptions were made later on to simplify the complexity of the multi-objectives that are mainly conflicting with one another. The author selected only one goal out of the multiple goals gathered and argued that the Islamic bank is assumed to operate as a profit oriented organisation and with this, there will be many conflicting objectives arising from the complex nature of the institution‟s operating environment. Given this reason, the author took only profit optimisation as the sole goal to be consistent only with the equity shareholders and depositors interests for value maximisation. The author continued to state that due to the participatory nature of the profit-loss sharing (PLS) system, both parties, the shareholders and the equity-like depositors (in this research it is referred to the *mudaraba* depositors) share the like objective, that is profit maximisation.

Motivated by this drawback and the research gap in this area, the study identified a method using deterministic linear programming with goal functions in financial modeling to establish the multi-objective optimisation model. This method (using deterministic linear programming) is considered by the literature as an elegant way to tackle the problems arising from Islamic bank asset liability management (Belouafi, 1993). It is useful when there are conflicting management desires, need and requirements or when there are more than one conflicting goals affecting the asset liability decisions. This problem solving approach is known as the fuzzy decisions with ranking process used by Belouafi (1993). The design of the multi-objective asset liability optimisation model takes similar form akin to the design by Belouafi (1993) and Kumar and Leonard (1988), starting with discussions about linear programming with goal functions and its solution to problems with multiple objectives, processes associated with the formation of the linear programming with goal functions, ranking of these objectives using fuzzy data management approach (the analytical hierarchy process) pioneered by Saaty (1980) the parameters obtained from this approach of goals ranking, decision variables, and the single period multi-objectives asset liability optimisation model.

3.7 Justification for the Data Processing Approach

It was discussed earlier in Section 3.6 that the data collection process challenges can be overcome using other reliable sources of secondary inputs such as asset liability management requirements[30] information from studies surveyed, research articles with similar models or methodology related to deterministic linear programming or optimisation related problems, models concerning multiple decisions and criteria arising from the asset liability management process.

These studies were scrutinised carefully. Approaches adopted by the two main studies, (1) Chong and Zak (2013) and (2) Belouafi (1993) were taken as the main reference as guideline to the design of algorithms and methodology for this research. Chong and Zak (2013) incorporated the fuzzy decision analysis in their optimisation model to aid decisions in resource management. The authors Refahe-Kargaran Bank an optimal way to achieve the best efficient resource allocation which also leads to a minima point of variance in the risk minimisation process. This approach of decision

[30] Most banks share similar banking capital requirements. This requirement can be found in Basel III on the new capital regulation and the date it is implemented worldwide (Bank Negara Malaysia, 2012).

ranking was first introduced by Saaty (1980). In a later research, Saaty and Vargas (2013) performed a literature survey related to all methodologies of model development using fuzzy decision model and found more attractive methods for decision making in asset liability management to decision makers of this field by carrying out group interviews on personnel from the treasury management. On the other hand, Belouafi (1993) followed the Kendall coefficient of concordance to measure the degree of agreement among the goals studied (i.e. maximizing profits, maximizing returns to the owners, minimising the risk of losses, maximizing return to depositors and others). Despite the fact that the author made simplified assumption that led to single objectivity optimisation, the method proposed in the ranking procedure to assign weights of importance for asset liability goals determined using a survey instrument distributed to 7 Islamic banks was analysed critically. The bank samples included in Belouafi (1993)‟s study were also targeted to confirm the generalizability of results obtained (the ranking for goals studied). This step is crucial to determine whether the results can be generalized to the asset and liability management objectives of BIMB that forms part of the bigger population of Islamic banking institutions in general.

It is found that the grouping of objectives performed by Belouafi (1993) was unclear. For example, the author grouped several differing objectives in his survey questions and he gave the weights of importance to these questions instead of the objectives studied. In order to provide clarity to the goals and its relative weights, efforts were also taken to analyse the parameters (weights) for these objectives from Chong and Zak (2013)‟s study as part of the current study‟s delimitation process. Reason for this prominent technique was the need to realize the research‟s contribution to the Islamic banking and operational research literature. Not only it has contribution in mathematical formulation, it also carries distinctions between religion compliance and contemporary finance in these math functions. Contemporary finance in related studies had documented mostly optimal asset liability management for interest-based institutions.

It is the aim of this research to fulfil the literature gap using the customised optimisation model for Islamic bank asset liability management as a base line model with the combination of the penalty cost method and deterministic linear programming technique that is validated using financial inputs from BIMB. The output is an optimal solution with an efficient set of asset mix and algorithms used to establish this model is documented[31].

3.8 Multiple Objectives and Constraints Analysis

Similar studies by Fortson and Dince (1977) modelled the asset and liability management problem using similar approaches with the multiple goals or objectives to represent the management‟s desires and constraints characterizing the operating context of a bank. Bearing in mind the fact that not all management‟s desires can be satisfied simultaneously, deviations (positive or negative) should be normal. Through the multi-objective linear programming with goal functions method, these conflicting goals can be satisfied by having the objective function to minimise the deviations of these goals. At the same time, some goals carry greater impact for positive deviations than other goals, while some with greater negative impact that is more intensifying than compared to other goals. Additionally, some may carry heavier impact for having negative deviation than the positive deviation. This complex nature of the balance sheet can be remedied by assigning relative differential weights (or priorities) to each deviation (positive and negative), to reflect their importance. According to Fortson

[31] See Section 3.11

and Dince (1977) in Kumar and Leonard (1988), this method is known as the pre-emptive priority factors treatment. As an example, consider the following treatment;

By denoting P_n as priority for goals 1 and 2, with $n = 1,2$, such ranking ($P_1 \gg P_2$) shows that goal with priority P_1 is more important than goal with priority P_2. Furthermore, this also implies that P_2 goal shall never be met until P_1 goal is fully met. As mentioned in Kumar and Leonard (1988) that practically, decision makers are willing to forgo or substitute under-achievement for P_1 type goals in certain times to an insignificant extent so that the P_2 type goals (Cohen and Hammer, 1967, 1972) which is categorised as higher achievement during different situations can be attained. This type of situation can be performed only through multi-objective linear programming with goal functions, not under the common linear programming with goal functions technique.

One may refer to Arbel and Orgler (1990) for details to fuzzy decision process modeling in finance, used to evaluate a bank"s acquisition strategy. For more reading on recent studies in analytical hierarchy process and its applications in portfolio allocations are Abrantes and Figueiredo (2014) who managed the dynamic new product development portfolio projects specifically to structure the scopes within the these portfolios; Jugend and da Silva (2014) who used the fuzzy analytical hierarchy process in product-portfolio management and projects evaluation while lengthening these aspects to include organisational strategic planning and portfolio reviews and so on.

Table 3.1 below provides an analysis and comparisons taken by the two main akin studies as reference for their methodology in goals intensity ranking;

Table 3.1: Summary Analysis for Multi Objective Optimisation Methodology

Items	The Kendall Coefficient of Concordance criteria, Belouafi (1993)	The Fuzzy Decision Making Process, Chong and Zak (2013)
Goals analysed	Profit maximisation Maximizing returns to owners Minimising risks of losses Maximizing return to depositors Cash holding objective Minimum capital preservation Liquidity requirements Social need for investment Decision for the choice of banking services	Performance revenue Capital Adequacy The deposit facility ratio Liquidity requirements Assets growth Fixed assets
Multiple objectives ranking methodology	Using Kendall‟s coefficient of concordance represented by W Ranked questions instead of the multiple objectives assigned to the questions[32] W measures the degree of consistency between the K ranks of the N objects K represents the number of items (goals) ranked among N (as the number of responses partaking this rank) W is denoted by this formula $W = \frac{S}{1/_2 k^2 (N^2 - N)}$ With S denoting the sum of squares for deviations for the mean of weighted importance (intensity of goals)	Used Fuzzy AHP This is a popular multi-criteria decision making tool that was initiated by Saaty in 1980. Despite the fact that the approach analyses decision maker‟s opinions, the analysis cannot be used to reflect the human thoughts which is complex and abstract. These analysis is confined to measures taken to capture the opinions at several intervals when the decision making environment changes. For this reason, it assumes that the judgements gathered from the decision makers are explicit (Steuer and Na, 2003). Steur and Na (2003) compiled the literature development of the multi-criteria decision making and

[32] For more details, please refer to Belouafi, A. (1993) Asset and liability management of an interest free Islamic bank, PhD thesis, University of Sheffield, Sheffield.

	their methodologies. Compared to other methods, the AHP requires only inputs form the decision makers. This is however the documented weakness faced by AHP. Weighting all relevant pros and cons of various multi-criteria models, Steuer and Na (2003) proposed the analytical hierarchical process to be among the best in multiple objectives evaluation.

Table 3.1 states clearly the essence of both approaches. Comparing these benefits and weaknesses plus suggestions by current literatures with supportive evidences and justifications, this research takes the outputs generated from Chong and Zak (2013)‟s study, as parameters (weights) for each goals investigated for the optimisation model. In order to enhance the reader‟s awareness to each step taken by the authors, an algorithm based on the approach by Chong and Zak (2013) is included in Figure 3.4 (the algorithm of penalty cost process) to illustrate weights generation with the approach by Chong and Zak (2013) for a computational solution that meets the model‟s criteria for convergence. A set of weights are obtained from this process. These weights provide an optimal asset liability combination for an optimised asset liability management.

Figure 3.4 in Section 3.11 started with the settings made to penalty cost process framework. Here, the goals are analysed based on their relevancy in the hierarchical sequence from the top level to the bottom levels, that is, the common goal for the problem and then to the specific lists of goals to the problem. Then, step 2 continues with comparisons[33] to each evaluation using linguistics variables[34]. the factors considered are usually not more than 7 to nine factors (Miller, 1956) as simultaneously analysis of these factors are considered difficult and complex to handle. As such Belouafi (1993) continued with only 6 factors while the thesis uses 5 factors; optimising the capital adequacy ratio, liquidity requirements, total asset growth, total deposit facility and total returns to *mudaraba* depositors.

These factors and the outcome of each weight are shown in Chapter 4, Section 4.3 to Section 4.4 and Table 4.9. The referred authors then used these factors (also known as the criteria) to form the hierarchy for a later assessment using the stepwise comparisons method. Since the thesis was unable to gather inputs regarding the multi-goals and objectives from the asset liability department managers, it is the approach then to assume weights obtained from similar studies like this one. Once the hierarchy is created, the assessment of criteria is performed using stepwise comparison. In some situations, the decision makers can specify preferences in the form of an analytical hierarchy process numerical stepwise comparison. This method was introduced by Saaty (1980) using a nine point of scale of importance between two elements. After that, the triangular fuzzy numbers consisting of the odd numerical values were used by the authors to represent the items‟ relative importance to its pairs.

Consistency checks using confidence interval of the decision makers were done to these conflicting goals. Step 2 to step 5 were repeated for each alternative evaluated. The final weights of the asset liability decisions were identified using the weighted sum of the weights criteria and alternatives. The final weights of the bank

[33] This method can also be used to perform decision analytics for incomplete information in group decisions (Ureña, Chiclana, Alonso, Morente-Molinera and Herrera-Viedma, 2014). The stepwise comparison involves comparing entities in pairs to determine which item is preferred or the one that has greater quantitative factors.
[34] Linguistic variables are common words used every day and it is a significant component in communication to covey a person‟s desires to another (Bank and Hayward, 2002). On the other hand, mathematical variables are usually in the form of numerical values, whereas, in the pertinence of fuzzy logic the non-numeric variables are usually used to relate expressions governing rules and facts.

balance sheet management were used as input to parameters of the linear programming with specific goal functions formulated for this research.

3.9 Formulation of the Asset Liability Management Model

The conceptual model of the research consists of parameters of decision making from the balance sheet items on BIMB‟s financial statement. This includes the on- and off- balance sheet items. Other financial statements that are useful to model the asset and liability management are the profit and loss statement and notes to financial statement, data from the Islamic Interbank Money Market, stock exchange (Bursa Malaysia)‟s, Bank Negara websites and the applicable Acts like Islamic Financial Services Act (2013). Decision variables are identified and explained. Assuming a non-dynamic single period model (following the deterministic linear programming characteristics), the linear characteristics of the asset liability model can be exemplified by entering relevant parameters into the objective plus rules, policies and regulatory concerned.

The position of the balance sheet depicts an organisation‟s sources and uses of funds. In the common balance sheet management environment, decision makers are usually faced with problems like the need to decide and establish the structure of the organisational balance sheet position, to provide allocations for sources and uses of funds arising due to complicated business dealings (especially in the case of the Islamic banking institutions that has limited non-interest bearing sources of funding), engaging in transactions that falls into different timing of execution between payment and the when intention to enter into such transaction is consented. Between these thoughts, the main goal in the art of banking lies in its profit and liquidity management. Stemming from these objectives there could be several subordinate objectives as part of the main goals achievement. While meeting these goals, it is important to acknowledge and work within BIMB‟s customised/ unique balance sheet positions. Models established in *silo* without referring to an institution‟s long term and operational asset liability management style will be inconsistent with the strategies developed (Chaturvedi, 2010; Kusy and Ziemba, 1986). These strategies are based on the institution‟s specific operating environment and characteristics. As a consequence, decisions made based on this model will affect the balance sheet position with outcomes that could possibly be detrimental to the organisation. Moreover, if the research establishes a model based on asset liability management style analysis from a period less than three years, the model will unlikely be reflective of the asset liability approach by BIMB. Results from the implementation of an asset liability strategy take time to emerge. This is known by the economists and mathematicians as distributed time „lags‟ or periods taken before an actual outcome of a policy implementation can be observed/ unfolds (Koyck, 1954, pp. 35-37). If this outcome takes place, it would have a lasting effect on that institution. It would sustain for a couple of periods which could range from weeks to years before an institution learns the source of this outcome and react to minimise any adverse effects from this source. Therefore, it is important for BIMB to act prudently in identifying regulatory and specific organisation requirements so that the bank can incorporate relevant management strategies into its unique operating framework. This framework should reflect all legal and regulatory requirements, the money market volatility and consumer needs and preferences management subject to *Shari'ah* compliance, and key responses in the event of changes in the economic environment (Chaturvedi, 2010).

The following section outlines problems arising from the unique balance sheet structure of Islamic banks in Malaysia with BIMB‟s balance sheet position taken as reference to this discussion.

3.9.1 Problem Setting: An Overview of the Bank's Asset Liability Problems

In order to have a robust asset liability management model, it is important for the financial modeler to understand the specific behaviour and characteristics of the balance sheet for the institution he is examining. In this process, all problems unique to that institution have to be identified and understood correctly. In the case of BIMB, all problems related to the bank‟s balance sheet structure along with unique product characteristics that are determined by the *Shari'ah* contracts as fundamentals to the transactions of these products must be considered. As we know, a financial institution is regarded by the literature as an economic entity attempting to optimise an ultimate objective function that is wealth maximisation (Bernanke and Gertler, 2000). It utilises several economic variables like asset prices and its associated break-even quantities as the controlling variables. The structure and design of the model depends heavily on the specific regulatory environment and the level of such regulation imposed on the bank (Harris, Opp and Opp, 2014). These regulations could affect the opportunity set and asset liability mix, restricting to the spheres of solutions available that may perhaps confine the bank‟s ability in acting towards its objectives.

3.9.1.1 Modeling the Balance Sheet

The asset liability management (also known as balance sheet management) model is a structural intertemporal decision making optimisation tool (Amenc, Martellini, Milhau and Ziemann, 2011) given the deterministic (non-dynamic) and the uncertain cash flows which affects the rates of returns would affect the organisation in the future. The stylized balance sheet category is quite multifaceted even within its simplest consolidated format. Even as such, the layout of the balance sheet determines to a significant extent the overall returns and expenses (Amenc, Martellini, Milhau and Ziemann, 2011. p. 59) borne by the bank. Before continuing to model the sophisticated nature of BIMB‟s balance sheet, the outline of such approach is detailed in the following parts of the chapter.

In summary, the asset liability management model is an intertemporal (Amenc, Martellini, Milhau and Ziemann, 2011. p. 59) decision making process guided by the optimisation tool to determine a set of assets and liabilities mix a bank, using the rates of returns and costs based on market and near term deposit rates for expected cash flows generation as inputs to the model. The asset liability management engages continuous portfolio revisions over the planning horizons. With this consideration, BIMB‟s strategic goals can also be investigated by analysing the financial ratios. It serves as part of the optimisation function constraints construction to reflect the bank‟s asset liability management policies and desired targets for asset liability performance. As part of the mathematical programming technique, a general formulation of the optimisation problem is required. It starts with decision variables identification, objective functions and resource constraints formulation. Mathematical notions and descriptions to each decision variable and the optimisation models are presented in Table 3.4 on page 163.

Steps Taken to Ascertain the Asset Liability Management Decision Variables

Firstly, before the construction of the asset liability optimisation model, a series of meetings with executives from BIMB was arranged to determine the overall paradigm of the asset liability system. These interviews started with discussions with the head of the *Shari'ah* Department to gather insights about religious impacts on the bank‟s assets and liability management. After the meeting with the head of *Shari'ah* department, a next meeting was scheduled with the head of the treasury department to solicit more information relating to the way BIMB‟s assets and liabilities were managed. The discussions started with the intricacies of assets and liabilities management where in both sessions, operational and linguistic terms were used to bring the dialogues into practical domains. These include the length of the planning horizons (i.e. a year or more than that), the assessment points if there is more than a single planning horizon (i.e. the Multi period decision span), as well as the number of balance sheet classes considered in modeling the assets and liabilities.

Right after the discussion with the director of the treasury department, the research has decided to establish a single year period optimisation model, encompassing 13 assets and 13 liability and equity variables. This single period model is used to validate the model in order to test the model‟s execution to find any discrepancies in programming and the design of algorithm documented in this research. Bear in mind that the single period concept should not be used to study BIMB‟s asset liability management style[35]. Even though the norm in the literature placed together the limitation contained in a single-period planning model such as its ignorance for intertemporal associations that could arise between these assets and liabilities, it was aware that the single-period framework will produce results that could be readily implementable and internalized by the management (Martellini and Milhau, 2011). Concerning the size of the model (that is, its single periodicity) the thesis extends its attention to insure that the model address BIMB‟s top manager‟s policy concerns which enables the models ability to capture the bank‟s perceptions about its operating environment. During discussion it was borne in mind that the mathematical jargons should be avoided because not all managers are math literates (Balbirer and Sha, 1981).

[35] It was discussed in Section 3.9 earlier that there is time lags between a strategy implementation and the outcome of that implementation (Koyck, 1954, p. 35-37).

With these inputs, the model can be formulated and its data needs are identified correctly and accurately. The main data inputs for the model‟s implementation are:

1) Forecasted yields on all assets including financial securities and financing categories.
2) Expected deposit rates and liabilities and equities.
3) Administrative and/or processing costs on major loan and deposit categories
4) Provisions for loan losses or non-performing financing
5) Maturity structure of all asset and liability classes

BIMB‟s financial statements are useful source of data for data inputs to the model. In events when important inputs are not available, such as the money market yields, investigations were carried out to fill this gap. The data gathering process were extended to sources from Bank Negara (the central bank)‟s websites, visits to the bank‟s knowledge centre in Sasana Kijang, Kuala Lumpur, calls made to the Malaysian Bond Pricing Agency, visits to the Putra University Malaysia for the Bankscope database access plus other approaches taken to fulfil data collection for the model. Balbirer and Shaw (1981) took measures to engage the senior managers in data collection wherein each senior designates were given the responsibility over a class of asset or liability so that they could participate in the process with the sense of „ownership‟ to the model developed.

However, it is difficult for this study to adopt this approach. Other PhD studies similar to this have resorted to methods similar to this research because of the motivation lack demonstrated by the industry representatives who are at most time occupied with their roles and responsibilities. Besides, it was challenging for the model to replicate the complexity by models of renowned researchers in the field due to data unavailability and the model‟s sophistication. The following section provides a clear description to inputs used for the optimisation model in the modeling process. These inputs are the outcomes of decision variables (or parameters) identified from the process discussed in this section and the sections before it.

3.9.1.2 Model inputs

(a) Forecasted Yields on All Assets Including Financial Securities and Financing Categories: Measuring Portfolio Returns

Pyle (1971) developed a model to maximise the value of the firm while capturing the dynamism and uncertainty of the rates of return to a bank. Nevertheless, Sealy (1980) advanced this model with an argument stating that these rates are usually set by the financial intermediary, who has somewhat monopolistic power over asset pricing in the financial industry (only few players). The author argued that these rates do not depend on the open market. Coupled with the banking supervision and regulatory framework, rates would not deviate far from the norms as this could jeopardize the industry as a whole. Thus the research considers deterministic data that covers historical returns obtained from the financial statements per se as part of the data delimitation for this thesis. The formula used to obtain the assets returns, considering n number of assets (X) for variable x, where $x \in X$, we can calculate the returns to these assets in period t as;

$$R_{n,t} = \frac{P_t - P_{t-1} + CI_t}{P_{t-1}}, \quad n = 1,2,\cdots,n \tag{3.4}$$

$where\ R_{n,t}$ = Return to asset x_n in time t

P_{t-1} = The price or value of the asset x_n in time $t-1$

P_t =The price or value of asset x_n in time t

CI_t =The cash inflow (current income) gained from holding the assets for time t.

Observing Expression 3.4 above, transaction costs[36] arising from the assets are not covered. Ahearne, Griever and Warnock (2004) laid out the fact that data on individual assets transaction costs are rarely made available to the public and normally, the costs are displayed for a portfolio of assets under mutual or trusts funds. This calls for the perfect market assumptions where nontrivial transaction costs exists, there is the subsistence of informational asymmetry, or there maybe monopolistic pressures from some of the bank‟s liabilities. Chapter 4 presents a set of solutions that satisfies the optimality conditions given the operating environment of BIMB in 2012 and 2013. The model‟s assumptions in Section 3.12 are useful to ensure the model‟s practicality and smooth imperfections for a parsimonious simulation process.

(b) Expected Deposit Rates and Liabilities and Equities

The deposit rates and the equity rates signify the bank‟s cost of funds. BIMB publishes daily profit rates for their General Investment Accounts for daily returns to their specific and general investment accounts for a regular period of one month, three months, six months and periods covering more than a year in Malaysian Ringgit in their website. Figure 3.1 shows snapshot of such information. The current base lending rate updated as at 2nd of January 2015 is 3.9%. Besides, data including the costs to funds obtained from the above categories of time deposits are taken as average values for one month (31 days) in Malaysian ringgit (MYR) for a trailing period of 16th January 2015 to 15th February 2015. The thesis accounts for estimates of the returns for

[36] The explicit transaction costs are fees and commissions arising from trading transactions whereas, implicit transaction costs are those arising from illiquid assets, its settlement costs and the costs associated to garnering its related information (Ahearne, Griever and Warnock, 2004).

a year period considering the simplicity of the optimisation model. The average returns for each asset classes are shown in Table 3.4. The mean annual deposit rates expected for BIMB are the costs of capital matched to their maturity structure. These averaged figures are based on the type of deposit products offered by BIMB. APPENDIX B shows the summary of these rates categorised based on the types of BIMB"s deposit products. These rates can be obtained from the BIMB"s websites.

In the process of financial modeling for returns (yields) of the money market securities, we refer to a baseline theory of the random walk process by Markowitz (1957) stated that the random movement of stocks in the capital market makes prediction difficult to the stock analysts. This process (random walk phenomenon) is the most common example of a Wiener process. However, mentioned in the previous section, it is fundamental to evaluate the forecasted returns for asset allocation optimisation. The returns of these securities are assumed to be normally distributed. Assuming normal distribution a security, x"s return or yield r_x can be calculated by letting P_{xt}^{M} be the price of security x (for example a 6 months or 180 days central bank *sukuk* (bond) BNM-i in period t, then P_{it}^{M-K} is the price of security x in period $M-K$ days to maturity. To calculate P_{i}^{M-K} when no yield is quoted for a security of that type for that maturity, the interpolation method can be used between two closest maturities available, depending on the data set on hand.

To illustrate, let us assume that the maturity between 5 months and 6 months security j offering a given yield with P_{j}^{M-K} and $M-K$ can be calculated as 173 days (taken arbitrarily here, though it can be calculated as the security"s time remaining to maturity). As the shape of short term government Islamic bond can be relatively flat. Refer to Figure 3.1 below,

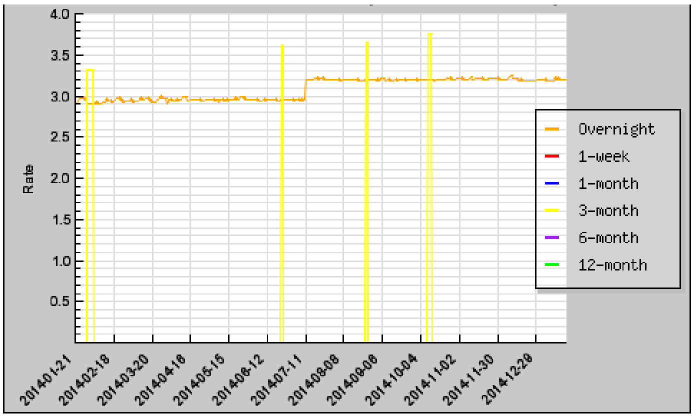


Figure 3.1: Islamic Interbank Interest Rates (21.01.2014 to 29.12.2014)
Source: Adapted from Bank Negara Malaysia Website, 2015

With the historical yields in Figure 3.1, one may obtain an Islamic interbank interest rate yield (R_{jt}) for period *t* for security *j* as;

$$R_{jt} = \frac{P_{jt-1}^{M-K} - P_{jt}^{M}}{P_{jt}^{M}} \tag{3.5}$$

$$t - 1 > 1, and\ t = \{2, \dots, n\}$$

Where;

n = Number of periods observed, in this case is weekly

R_{jt}= Weekly returns of asset *j*

P_{jt}^{M}= Price at maturity

P_{jt}^{M}=Expected price within time to maturity

Expression 3.5 above enables us to calculate the return for money market securities given that the short term yield curve is relatively flat. It is a simplified version of Expression 3.4 discussed in Section 3.9.1.2. For a weekly excess return calculation, we can take the difference between the instrument‟s weekly prices and its remaining to maturity given the above formula and divide it with its price at time *t*.

In order to fulfil the search an efficient set of asset allocation that maximises the portfolio returns and minimising the deviations from decisions including target returns to shareholders, *mudaraba* depositors, capital adequacy requirement, liquidity, total asset growth and the aimed amount of funds availability from the deposit accounts), the formula above will be used and the security‟s corresponding chances of occurrence with confidences between 80%, 90% 95% 98% and 99% to encapsulate difference occurrences during recession and boom economic performance. This is performed to accomplish Research Objective Three (3), that is to identify an efficient asset, liability and equity composition itemised on the balance sheet of BIMB. In this case, BIMB is taken as prototype to validate the model. The model is flexible to be customised to suit the unique operational and strategic needs of other Islamic banks in Malaysia.

All computations with regards to the formulas expressed earlier are used for the formulation of the following functions as part of asset liability management objectives:

1) Capital adequacy as operational and market risk mitigation approach
2) Liquidity provision
3) Percentage of total asset growth on annual basis
4) Total deposit facilities available as the bank‟s source of capital
5) Total return to *mudaraba* (profit sharing) investors or account holders

(c) Administrative and/or Processing Costs on Major Loan and Deposit Categories

Depositors in the Islamic bank places money with the bank and they are allowed to withdraw according to their demand from that bank. The bank may charge the depositors a fee for services provided to deposits custodial and when it deems fit it shall allocate a portion of gift (also known as *hibah*) to the depositor. This concept arises from the deposit-taking facility which includes the custodial or safe keeping services. These are the common costs arising from administrative processing costs for deposit categories. In BIMB‟s financial statement, this cost is construed as the direct expenses before arriving at the „Income attributable to depositors‟. As for the loan processing fee, BIMB charges no loan processing fee[37] for personal financings that are *Shari'ah* compliant.

(d) Provisions for Loan Losses or Non-Performing Financing

A loan loss provisions are allocated when losses are foreseen as consequences form lending and financing activities (Anandarajan, Hasan and McCarthy, 2007 in Misman and Ahmad, 2011, p. 94). Like the accounting treatment, the loan loss provisions are used in managing the bank‟s capital and earnings (p. 94). Misman and Ahmad studied the use of the loan loss provisions in Malaysian Islamic banks practices as a mean to manipulate the levels of earnings and capital. However, it is not the within the scope of this study to provide such coverage. It is only the interest of this section to give the readers a brief idea on how the loan loss provision is accounted for within the financial statements of the Islamic banks, including BIMB for

[37] The information about „no loan processing fee chargeable‟ is available from the bank‟s website at https://www.google.com.my/url?sa=t&rct=j&q=&esrc=s&source=web&cd=3&cad=rja&uact=8&ved=0CCoQFjAC&url=http%3A%2F%2Fe-pinjaman.com%2Fbank-islam-personal-financing-i%2F&ei=iB3LVPf3PM798QWe3IKIDg&usg=AFQjCNHnf-oYrkTeV9rqBKs5lKo6bqVQOA&sig2=5WKfnIlYZeYu4QgGftl5tQ&bvm=bv.84607526,d.dGc

the purpose of the model‟s input. The Islamic Financial Services Board (IFSB) mandates the Islamic banks to disclose the amount of loan loss provisions in the income statements (Misman and Ahmad, 2011). The loan loss provisions appear as „allowance for impairment on financing and advances‟ in BIMB‟s „Statement of profit or loss and other comprehensive income‟. The International Accounting Standard 39 (IAS 39) covers the taxability treatment for specific loan loss provisions. BIMB deducts the „allowance for impairment on financing and advances‟ before distributing the agreed portion of returns to its depositors in order to comply with IAS 39.

3.9.1.3 Maturity Structure of All Asset and Liability Classes

The System of National Accounts (1993) determines the factors affecting security and protection of a bank‟s financial structures with reference to financial security framework. This framework encourages a comprehensive, consistent and flexible set of macroeconomic accounts to meet the needs of government and private-sector analysts, policy-makers, and decisions-takers. It was prepared jointly by the International Monetary Fund, the European Union, the Organisation for Economic Co-operation and Development, the United Nations, and the World Bank. System of National Accounts (1993) contains descriptions of financial securities (both assets and liabilities of financial institution) that can flexibly accommodate the different structures of the unique banking system. It was first initiated with the objectives to meet the need of the government and private institutions in analysing, policy formulation, aiding decision process of both government and private institutions. It was also jointly established by the International Monetary Fund (IMF) the European Union, Organisation of Economic Co-operation and Development, the United Nations and World Bank (Branch, 2012).

The System of National Account serves as an important guideline on how the financial securities assets are classified in this study because the maturity of the assets will affect a portfolio‟s cash flow. According to System of National Account‟s 1993 guideline, assets under the System of National Account (1993), assets qualified under this scheme are grouped depending on its liquidity and maturity while incorporating one or more features governing specific features like its negotiability, marketability, transferability, convertibility in to its near cash form, along with the legitimate relationship between its creditor and debtor. Although not separately identified, these specific characteristics of liquidity play a major role in determining the asset and liability categories in a balance sheet. In order to have a clearer view about the structure of a balance sheet, Table 3.3 presents the maturity profile of BIMB‟s assets and liabilities.

The maturity profile reflects profit rate sensitivity[38] of the assets and liabilities involved. Based on the relevant maturity structures, BIMB classified its financial securities according to these three main groups. In essence the liquidity structure is the main determinant to the characteristics of these financial assets. They are the held-for-trading, available-for-sale and held-for-trading securities. Held-for-trading securities are debt and equity securities purchased with the objective to sell them in the very short term for returns. They are usually adjusted at market value in the balance sheet. Alternatively, unrealised paper losses or gains will be recorded in the profit and loss statements.

The International Accounting Standards (IAS 39.3) holds that the held-for-trading securities are those financial assets that are acquired for the short term purpose with the intention for short term profit and it carries the characteristics of

[38] The profit rate sensitivity test is a measure of how much the price of a fixed-income asset will fluctuate as a result of changes in the interest rate environment. Securities that are more sensitive will have greater price fluctuations than those with less sensitivity

pattern trade (buying and selling within very short period). Securities categorised under the held-for-trading assets are; Malaysian Government Investment Issues, Bank Negara Negotiable Notes, Islamic Debt Securities, Islamic Commercial Papers, and the Malaysian Islamic Treasury Bills. The IAS 39.9 provides that the available-for-sale categories of financial securities are those that have not been classified under the loans and receivables, held-to-maturity assets, or even financial assets held-for-trading. The available-for-sale securities consists of both debt and equity securities holds characteristics that are somewhat similar to the held-for-trading securities with the exception that paper (unrealised) losses or gains as a consequence from holding these types of securities will be reported in the other comprehensive income forming part of the common stockholders" equity.

The Available-for-sale category consists of all securities quoted at their fair values includes. It includes unit trusts, the Malaysian Government Investment Issues, Negotiable Islamic Debt Certificates, Islamic Debt Securities, Islamic Development Bank Unit Trust, the unquoted shares in Malaysia (after impairment loss) as well as unquoted shares outside Malaysia. The third category of financial securities classification is the financial assets held-to-maturity. They are unquoted securities in Malaysia, the Islamic Debt Securities (after adjustments for impairment losses). Table 3.2 below provide the term structure of the three classes of financial assets discusses earlier. These assets categories are used as the model"s decision variables and are detailed in Section 3.9.2.

Table 3.2: Financial Assets and Its Categories According to the IAS 39 or IFIS 9[39]

Held-for-trading	**Available-for-sale**	**Held-to-maturity**
Malaysian Government Investment Issues	Unit trust	Unquoted securities in Malaysia
Bank Negara Negotiable Notes	Malaysian Government Investment Issues	Islamic Debt Securities (after adjustments for impairment losses)
Islamic Debt Securities	Islamic Debt Securities	
Islamic Commercial Papers	Negotiable Islamic Debt Certificates	
Malaysian Islamic Treasury Bills	Islamic Development Bank Unit Trust	
	the unquoted shares in Malaysia (after impairment loss)	
	unquoted shares outside Malaysia	

Note: The classifications are also based on BIMB‟s balance sheet, „Notes to Financial Statements‟ classifications.

The securities portfolio elements of the maturity structure of BIMB are itemized in Table 3.3 to provide views of the current securities contributing to the bank‟s asset liability optimisation model.

Table 3.3: An Example of the Non-Trading Book Items Exposure to Profit Rate Risk[40]**: Consolidated Financial Statements (As at 31 December 2013)**

Maturity Assets	Less than 1 year (RM‟000)	From 1 to 5 years (RM‟000)	More than 5 years (RM‟000)	Total (RM‟000)	Effective profit rate (%)
Cash, balances and placements with banks	3114790	n/a	n/a	3114790	2.26
Financial-assets-held for trading	n/a	n/a	1216895	1216895	2.51

[39] The financial reporting and disclosure have become more user friendly since December 16, 2011. The IASB (International Accounting Standards Board) and the FASB (Financial Accounting Standards Board) under IAS 39 and IFRS have made disclosure among institutions more common and harmonized areas between the two criteria, read IFRS 9. Additionally, Walton (2004) extended the debate on reporting requirements stipulated under IAS 39 and IFRS 9. Later on, both accounting standards have improved to remove major delinquencies that are confusing among professional practitioners.

[40] The profit rate risk defined by BIMB is the rate of return risk that imposes potential impact on the bank‟s profitability. These are affected by the change in the market rates of return, specifically due to the market movements or the borrower or issuer‟s specific conditions (BIMB Annual Report, 2013). This risk type is part of the market risk exposure experienced by the bank. Other risks that are classified under this broad risk are the foreign exchange risk, equity investment risk, commodity inventory risk, liquidity and displaced commercial risk.

Derivative financial assets	n/a	n/a	29118	29118	1.04
Financial assets-available-for-sale	3249238	5727754	3439929	12416921	3.96
Financial assets-held-to-maturity	n/a	n/a	63327	63327	9.06
Financing, advances and others (net impairment losses and impaired allowances)	2719896	2130053	19107269	23957218	6.25
Total	9083924	7857807	23856538	40798269	

Source: BIMB, Financial Statements (2013), Notes to Financial Statements, p. 82

Note: The N/A denotation represents non-availability of the investment referred due to portfolio rebalancing by the fund managers of the above asset classes.

The assets in Table 3.3 especially cash, balances and placement with other banks (term or demand deposits) and other assets includes non-profit sensitive amounts, considering its immaterial portion out of the total values they carry on the bank‟s balance sheet. The ratio between trading and non-trading book is calculated as the trading book items divide non-trading items.

As we can see the structure above, banks hold more liquid assets than other businesses. Even though there is higher asset allocation to the financial assets available-for-sale bank‟s maturity structure is dominated by the heavy portion of short to medium term assets. The discussions below provide further details on BIMB‟s the current assets composition starting with the components of its securities portfolio and then the financing and advances categories shown on the bank‟s books. As part of their sustainable growth, optimising balance sheet mix has become one of their major activities. The asset quality of the bank stood at a foundation of RM 37,422.9 in December 2012 and RM 42,811.4 as at the end of December 2013. This increase was part of the cause of improved pre-tax profit reported at RM 597.4 million in the year 2012 and RM677 million reported at the end of 2013.

Recalling the bank"s distressed position in 2006, the bank has endured a financial restructuring in year 2008. Led by Dato" Sri Zukri Samat, the managing director of BIMB, the bank begun to show improvements and better performance starting end of year 2010 (Lai, 2014). This was clearly seen in the increased number of quality and healthy assets reported as at the end of June 2010 (Chan and Kong, October 2014). Furthermore, statistics reported by the Rating Agency Malaysia (RAM) showed declining gross impaired financing ratio from 4.5% out of the total available financings to 1.2% as at the end of March 2014. This implies better credit ratings taken by the bank before the grant of any credit facility. As we can observe from Table 3.3 above, the largest portion of the bank"s total assets consists of securities investment, which is RM23,740,948, or 32.06% of the total assets value at RM42,811,371. Investigating the investment strategy by BIMB, it is noticed that the bank has reduced its assets allocation to investment securities from 42% at the end-of June 2010. Since the end of 2010, asset allocation has increased for investment securities from 42% to 32.06% at the end of December 2013. The composition of investment securities by the end of March-2014 are 37% of the investment securities portfolio, 20% consisting of cash, placements and other short term near cash items.

Under the RAM ratings report by Chan and Kong (October 2014), BIMB is fairly conserved in its portfolio management. The portfolio is characterized as somewhat low in credit risk with only a raft figure of 5% of its treasury investments are represented by the Malaysian Government, quasi-government investments, AAA-rated investments (taking a portion of 23% of the bank"s securities portfolio) and 13% representing AA-rated investments. The RAM investment rating agency further commented that they researched that the bank follows a policy of taking only investments in debt securities with AA or higher ratings and that the maturity structure of these investments are mainly characterized by short to medium term assets. Moreover, the bigger portion of the bank‟s financing assets involved mostly *murabaha*h (mark-up sale) based transactions at 30% out of the total financings, advances and others and *ijara* stood at 16% of the portion in the financings portfolio. These two main financing types occupied the bank‟s financing structure, forming part of the bank‟s „left-hand-side‟ of balance sheet. Section 3.8.2 below describes the items (decision variables) that are used to develop the bank‟s model.

3.9.2 The Balance Sheet Items and the Decision Variables

Decision variables are defined as parameters with values that are within the decision maker‟s control. Similarly, the term „variable‟ represents a factor which changes according to changes in the system or environment it interacts (Capiński and Zastawniak, 2003; Johnson Jr, Johnson and Buse, 1987). An optimisation problem is usually initiated with the identification of the decision variables. It could represent amounts of resources used (like funds for allocation to specific investments) or the amount of various activities channelled to operating units. The decision variables can be in the form of binary or continuous form variables (Xidonas, Mavrotas and Psarras, 2010). In this thesis, decision variables encompass items in BIMB‟s balance sheet (since this is the objective to maximise the assets and liabilities of the bank). For instance, the decision variables are the assets and liabilities (including equity items). These items will be discussed in further details in the following section. Saying this, we need to first point out all notations for the asset, liability and equity categories forming part of the optimisation model are summarised in Table 3.4. Besides, Table 3.5 provides a detailed application of the *Shari'ah* contract BIMB‟s balance sheet items.

Table 3.4: Notation for the Asset Liability Management Parameters

Variable (assets liabilities and equities)	Asset Category	Variable designation	Liability Category
X_1	Cash, and other short term near cash liquid assets	Demand deposits: *mudaraba* funds	
Financing, advances and others		Y_1	Savings deposits
X_2	*Bai"bithaman Ajil*	Y_2	Specific Investment Account
X_3	*Bai' al-'inah*	Y_3	General Investment Account
X_4	*Ijara*	Demand deposits: Non-*mudaraba* funds	
		Y_4	Demand deposit from customers
X_5	*Murabahah*	Y_5	Negotiable Islamic Debt Certificates, Ziyad and others
X_6	*Tawarruq*	Other types of deposits	
		Y_6	Deposits and placements from other financial institutions
X_7	Other modes of financing	Other Liabilities	
Investment securities portfolio		Y_7	Bills and Acceptances Payable
X_8	Held-for-trading securities	Y_8	Other liabilities, accrued zakat and tax liabilities
X_9	Available-for-sale securities	Y_9	Derivative financial liabilities
X_{10}	Held-for-trading securities	Equity Category	
X_{11}	Derivative financial assets	Y_{10}	Paid up capital
X_{12}	Statutory reserve	Y_{11}	Share premium
X_{13}	Non-current assets	Y_{12}	Retained earnings
		Y_{13}	Other reserves

Table 3.5: Application of *Shari'ah* Contracts to BIMB's Balance Sheet

Underlying *Shari"ah* concepts	Contractual Agreements
Assets	Liabilities
Asset-backed transactions	Demand deposits
Bai"bithaman Ajil (BBA)	*Wadi"ah Yad Dhamanah*
Murabahah	*Qardh*
Ijara	*Wadi"ah* and *Mudaraba*
Al-Ijara Thumma Al-Bai' (AITAB)	
Istisna	
Salam	
Bai"Sarf	
Bai"Dayn	
Bai"Inah	
Musharakah	
Profit sharing transactions	Investment Accounts
Mudaraba	*Mudaraba* Mutlaqah
Musharakah	*Wakalah bil-Ujrah*
Banking services: Fee based	Special investment accounts (SIA)
Wakalah	*Mudaraba*
Kafalah	*Muqayyadah*

Source: BIMB, A presentation on „*Shari"ah*compliance and risk management" by the top management at the *Shari"ah*at BIMB.

Table 3.6: BIMB's Actual Balance Sheet Data for 2012 and 2013 (in RM '000)

Variables (assets, liabilities and equities)	Current allocation			
	2013		2012	
	in RM „000	in Ratio	in RM „000	In Ratio
X1	3730911	0.0871	1695908	0.0453
X2	9162344	0.2140	8720001	0.2330
X3	1282498	0.0300	1512593	0.0404
X4	250897	0.0059	237515	0.0063
X5	841338	0.0197	1403165	0.0375
X6	**12477947**	**0.2915**	**7727660**	**0.2065**
X7	227496	0.0053	7734865	0.2067
X8	1216895	0.0284	1610558	0.0430

X9	**12416921**	**0.2900**	**12916055**	**0.3451**
X10	63327	0.0015	178291	0.0048
X11	**29118**	**0.0007**	**16736**	**0.0004**
X12	1297100	0.0303	1059900	0.0283
X13	274755	0.0064	1391554	0.0372
Total Assets	**42811371**	**1.00**	**47146591**	**1.00**
Y1	2295278	0.0536	1942190	0.0412
Y2	18659039	0.4358	12923159	0.2741
Y3	2012162	0.0470	2173818	0.0461
Y4	12267323	0.2865	11479233	0.2435
Y5	1923178	0.0449	3954028	0.0839
Y6	88022	0.0021	78562	0.0017
Y7	170598	0.0040	385138	0.0082
Y8	525396	0.0123	509181	0.0108
Y9	13565	0.0003	14339	0.0003
Y10	2265490	0.0529	2298165	0.0487
Y11	3624784	0.0859	9487007	0.2012
Y12	6874239	0.1606	1064296	0.0026
Y13	741474	0.0240	837475	0.0178
TOTAL	**42811371**	1.0000	**47146591**	1.0000

Table 3.6 provides a clearer picture of the balance sheet items arranged according to the different types of contracts *Shari'ah* based Islamic contracts. More readings can be obtained from Section 2.6 of the thesis. Whereas, Table 3.6 exhibits the asset, liability and equity categories forming part of BIMB"s asset liability management model. They convey the Malaysian Ringgit (MYR) currencies. The subscript X_n denotes all assets contain in the balance sheet, with n representing the number of asset from $n = 1,2,\cdots,13$. On the contrary, Y_m denotes the liabilities and equities with $m = 1,2,\cdots,13$, showing all 13 of such variables on the bank"s balance sheet. The asset

categories are sub-divided into their main groups of characteristics (the liquidity and objectives of investment). They are „financing, advances and others" and the „investments securities portfolio". The following sub-sections of Section 3.8.2 discuss with examples, variables and items of the balance sheet (asset and liability items separately).

3.9.2.1 Assets

(a) Cash and Other Short Term near Cash Liquid Assets

These are the items that are most liquid on the bank"s balance sheet. The investment dictionary defines liquid assets as those with customary and established market. It signifies having sufficient buyers and sellers to act upon the selling and buying transactions quickly thereby reflecting the fair price of the asset. Not only that, ownership transferability can also be done with ease and therefore, the market value of such assets would unlikely be impaired. Among all items on the bank"s balance sheet, cash is considered as the most liquid item.

(b) Financing, Advances and Others

Generally, the largest item on a bank"s balance is usually represented by consumer based products or the consumer banking. It is usually the biggest constituting element of the bank"s assets. Some of these major financings are the consumers" residential property, car and personal financing. The Islamic banking deviates from the conventional banking in its policy for non-interest bearing transactions (Dusuki and Abdullah, 2011). Besides, the bank is also governed by other Islamic permissible and encouraged way of doing business. In the light of this concept, the type of financing products can also be divided according to contracts governing its functional principles.

The contractual agreements prevailing to the different types of lending facilities are; deferred payment sale (*Bai'bithaman Ajil*), sale and buy-back (*Bai'al-'inah*), lease (*Ijara*), cost-plus (*Murabaha*h), *Tawarruq* plus other modes of financing.

The modes of financing above are categorised according to the kinds of financings available in BIMB. Defining the above based on the bank"s operational definition, we have;

i) *Bai'bithaman Ajil*

Under this financing facility, BIMB will initiate the purchase of the agreed assets and then upon the maturity of the contract, the bank sells back the contracted assets. The sale cost includes assets cosy with an additional agreed margin between the bank and the customer at the time of contract.

ii) *Bai' al-'inah*

This type of contract has been used widely among the Malaysian Islamic transactions. Nonetheless, it is still within the concernment of the jurisdictions due to different thoughts arising from the *Shari'ah* scholars. This type of financing arrangement has been widely disagreed by the Islamic banks in Middle Eastern countries (Rosly and Sanusi, 1999). With this controversy, its application limited ideally and the *Shari'ah* scholars encourages contracts that are *mudaraba* or *musharakah* based. In the context of BIMB financing, this type of financing agreement is commonly used to finance products or fixed assets acquisition.

iii) *Ijara*

The *Ijara* contract is a type of lease between a lessee and a lessor with the lessor passing unto the lessee the right to benefit and use an asset for an agreed rental to be made within the consented period. There are two type of *Ijara* financing available in BIMB, the operational ease and *Ijara Muntahiah Bittamleek* or *Ijara Thumma al-Bai"*(AITAB). Also, the *Ijara wa Iqtina*, the financial lease, a lease that constitutes to the transfer of the asset"s ownership at the termination or end of the lease duration either through gift (*hibah*) or sale with a specified consideration.

iv) *Ijara Thumma al-Bai"*(AITAB)

It is a mode of financing used widely by the Malaysians especially in car financing, also known as a hire purchase agreement, this type of contract can also be used to finance other range of assets acquisition. It is an innovation between features of the cost-plus and deferred payment sale (*bai"bithaman ajil*) agreement (Bakar, 2000).

v) *Istisna*

This contract is used usually in home financing. In the case of BIMB, it is a financing facility for retail customers who wish to purchase residential property which is to be constructed or still under construction. Customer enters into the first *Istisna* agreement by appointing the Bank as contractor to construct a project. The Bank appoints the customer as its agent to find a contractor. The Bank enters into the second *Istisna* agreement with the contractor via customer as an agent to construct the same project with the same detail and specifications. The Bank disburses the cost of construction to the contractor in the second *Istisna* agreement. The customer pays the cost of construction to the Bank on deferred payment basis. The project is delivered to the customer upon its completion and followed by full settlement of *Istisna* price to the Bank. In BIMB context it is a request to Bank to construct a specified type of asset. Technically, it is an agreement to sell to or buy from a customer a non-existent asset which is to be built according to the ultimate buyer"s specifications and is to be delivered on a specified future date at a predetermined selling price.

vi) *Murabahah*

In the context of BIMB this contract represents an agreement where the seller (Bank) sells the goods owned and available in its possession to a customer at acquisition cost (purchase price plus other direct costs) with the inclusion of an agreed profit margin. Technically, in this contract the seller declares his cost and profit. This has been adopted as a mode of financing by a number of Islamic banks. As a financing technique, it involves a request by the client to the bank to purchase a certain item for him. The bank does that for a definite profit over the cost which is settled in advance. Some people have questioned the legality of this financing technique because of its similarity to *riba* or interest.

vii) *Tawarruq*:

The *tawarruq* scheme is an innovative product operating within the combination of two *Shari"ah* contracts namely *bai" murabahah* and *wakalah*. Readers can refer to Chapter 2 for better understanding of these concepts. The *tawarruq* financing is often available to house financing. BIMB offers this as its *Baiti* Home Financing, also known as the comprehensive and best full *Shari'ah* compliant product.

(c) Investment Securities Portfolio

i) Held-for-trading securities

This portfolio consists of assets such as the Malaysian Government Securities, Bank Negara Negotiable Notes, Islamic Debt Securities, Islamic Commercial Papers and Malaysian Islamic Treasury Bills. As mentioned in the sections above, these types of securities are held with the objective to trade them in the very short period of time for returns.

ii) Available-for-sale

BIMB‟s available-for-sale securities portfolio consists of those between the medium and short term and medium and long term. The values are all quoted at their fair amount. The portfolio contains unit trusts, the Malaysian Government Investment Issues, Negotiable Islamic Debt Certificates, Islamic Debt Certificates, Islamic Development Bank Unit Trusts, Unquoted shares in Malaysia (net impairment losses) which is valued at cost, and unquoted shares outside Malaysia valued at cost.

iii) Held-to-maturity securities

Stated on the bank‟s balance sheet, the portfolio carries assets that are not meant for the near term trading. They are the unquoted securities in Malaysia and Islamic Debt securities after accumulated impairment losses. These assets are quantified at their amortized cost[41].

iv) Derivative financial assets

A financial derivative is an instrument with values derived from the value of an underlying asset. It is the outcome of sophisticated financial engineering and innovation. The conventional derivatives market is enormous and is rapidly growing. Average daily trade volume of 4 million contracts Reported total notational amount or bookkeeping value of US$330 trillion In conventional markets, have been used for Hedging purposes, to mitigate risks Trading or speculation Arbitrage opportunities-: Islamic Derivatives Development of an

[41] The amortized cost reflects the portion of cumulated costs of a fixed asset that are written off as expense. The method of accounting treatment is similar to that of the depreciation (Cairns, 2006).

Islamic derivatives market has been somewhat limited given many scholars‟ reservation towards the *Shari'ah* permissibility of derivative instruments Financial engineering in the Islamic finance space has mostly culminated in the form of Off-the-market, counterparty-specific arrangements for risk management purposes For example, profit rate swaps (fixed for floating)With the exception of some *Shari'ah* jurisdictions (for instance, SAC of Malaysia‟s SC who has approved CPO and stock index futures), the majority of scholars does.

(d) Statutory Reserves

Statutory Reserve Requirement (SRR) is a monetary policy instrument available to Bank Negara Malaysia (BNM) for the purposes of liquidity management. Effectively, banking institutions namely commercial banks, merchant/investment banks and Islamic banks are required to maintain balances in their Statutory Reserve Accounts (SRA) equivalent to a certain proportion of their eligible liabilities (EL), this proportion being the SRR rate. Currently, BNM believes that our banking system is lack of liquidity, thus it may raise the SRR to "store" more money in banks. Effective 1 March 2009, the SRR rate for banking institutions is 1% of EL. As of 1st September 2007, the EL base consists of ringgit denominated deposits and non-deposit liabilities, net of interbank assets and placements with BNM. As explained above, higher SRR means that banks in Malaysia will have to keep more money as their reserve.

(e) Non-Current Assets

The year saw BIMB‟s asset growth at 14% per annum, in line with the government‟s aspiration of 15% growth for Islamic Banking as underlined under the

Economic Transformation Program (ETP, 2010, p. 54). (1) Non-current assets for a bank could be anything from buildings used as bank branches to office equipment. These are used in the regular course of business, as part of the process of producing income. (2) Other Real Estate Owned (OREO) are assets that the bank owns, usually obtained through foreclosure. The yields or returns of banks are usually derived from the assets held, however, OREO generates expenses.

Property, Plant and Equipment, another type of non-current asset is reported net of depreciation and impairment from January 2013 onwards. BIMB‟s total assets have grown by 9.3%; that is RM13,426,139 in year 2012 to from RM12,282,776 in year 2011.

3.9.2.2 Liabilities

***(a) Mudaraba* Funds: Savings Deposits**

This liability item is a *Mudaraba* Savings Account-i shown on BIMB‟s balance sheet. The bank offers the unique *Mudaraba* Savings Account facilities. These facilities are based on the *mudaraba* contract, which entails the concept of profit sharing. One enjoys the profit gained from investment according to a predetermined ratio made at the commencement of the account. Some of the benefits of this account are its attractively competitive profit sharing ration and the historical monthly returns to its accountholders. The total return is credited directly into *Mudaraba* Savings Account-i. Free account‟s statements or passbook will be provided upon the customer‟s request.

***(b) Mudaraba* Funds: Specific Investment Account**

The unrestricted investment accounts consist of both the „Specific Investment Accounts‟ and the „General Investment Account‟. This is a Special Investment Account (SIA) whereby one may invest a sum of money with BIMB and profit (if any) is payable on every interim profit payment date/at maturity (where applicable). *Mudaraba* (profit sharing) is a form of partnership between one who contributes capital (*rab al-mal*/capital provider) and the other who contributes efforts in the form of managerial skills (*mudarib*/manager). Profit from the outcome of the partnership is shared between the capital provider and manager according to mutually agreed profit sharing ratio whilst losses are borne solely by the capital provider, provided that such loss is not due to the manager‟s negligence or violation of specified conditions: *tanazul*- With this concept, the SIA accountholders/ investors agree that their distributable income shall equate the expected profit from the portfolio of specific investments managed by the bank.

***(c) Mudaraba* funds: General Investment Account**

This is a General Investment Account (GIA) with profit payable at maturity. The General Investment Accounts usually carries a maturity profit distribution period of (1) 12 months and below, (2) or every 6 months until maturity date for GIA with above 12 months‟ tenor. The applicable *Shari‟ah* contract is *mudaraba*. This refers to profit loss sharing agreement between the investment account holder and the Islamic bank.

(d) Demand Deposits: Non-*Mudaraba* Funds

BIMB offers the Current Account facility for safe custody of the client‟s cash. This facility, which is based on the *wadiah* contract, enables one to wisely plan monthly expenditures while allowing the accountholder to manage financial needs without involving cash. Holders of this type of account benefits in several ways; (1) right to token (*hibah*), (2) right to obtain additional services from the bank on salary crediting and sweeping facilities representing standing instructions from the accountholders to the bank for, fixed monthly or yearly expenses like bill payments, rental, instalments, and so on. The accountholders are also entitled to have free statement printing at Statement Printing Machine Other facilities at BIMB bank branches nationwide.

(e) Non-*Mudaraba* Funds: Negotiable Islamic Debt Certificates, Ziyad and Others

Islamic Negotiable Instruments (INI) refers to a sum of money deposited with the bank and repayable to the bearer of this contract on a specified future date. Negotiable Islamic Debt Certificate (NIDC). The instrument represents a method of sale with payments (including profit margin) made in near future agreed by both the Bank and the customer.

On the other hand, Islamic Negotiable Instruments of Deposit (INID) refers to a sum of money deposited with the bank and repayable to the bearer on a specified future date at the nominal value of INID plus declared dividend. The underlying *Shari'ah* contracts governing this product is the *mudaraba* (profit sharing) contract, which allows profit loss sharing between the bearer and the bank.

(f) Other Types of Deposits: Deposits and Placements by Other Financial Institutions

This account consists of deposits that are categorised into two pools of funds, *mudaraba* and non-*mudaraba* funds. BIMB has temporary cash repositories with their peer banks for short-term yield/ return. It is worthy to have the assets to be placed for beneficial uses than having it idle and not used for good purposes to promote the business‟ growth. Moreover, it provides short-term emergency liquidity in times when cash-out needs arises so that the placement can be transformed into cash quickly. These placements are usually done with other Islamic banks, licensed banks, licensed finance companies, licensed merchant banks, Bank Negara Malaysia, and other financial institutions that are *Shari'ah* compliant.

Other than those platforms discussed here, the bank could also choose to have these placements with the Islamic money market short-term deposits, pension warrant deposits and penalty deposits on lent (deposits initially received from banking institutions for noncompliance with BNM's guidelines on lending to priority sectors).

Amount Due from Designated Financial Institutions refers to "claims by reporting institutions on foreign banking institutions". Institutions which are booked in MYR overdrawn vostro accounts, MYR nostro accounts, MYR surplus amount, MYR interbank placements, foreign exchange nostro accounts and foreign exchange interbank placements. Other Non-Banking Institutions refer to non-bank entities, i.e. nonbank financial institutions, business enterprises, government, individuals and other entities. Amount Due to Designated Financial Institutions refer to "the amount of claims by designated financial institutions on a reporting institution in MYR vostro accounts, MYR overdrawn nostro accounts, MYR borrowings, MYR interbank borrowings, foreign currency overdrawn nostro accounts, foreign exchange interbank borrowings and IBS MYR and foreign exchange amounts due to designated financial institutions which are the IBS equivalents of the aforementioned items."

(g) Bills and Acceptances Payable

The next asset item on BIMB‟s balance sheet is the "Bills and acceptances payable". These assets represent the Bank‟s own bills and acceptances rediscounted and outstanding in the market (See BNM/GP8-i, August 2003). Bills Payable refer to amounts payable to various beneficiaries arising from the sale of bank drafts, cashier's orders, mail transfers, telegraphic transfers and gift cheques.

(h) Other Liabilities, Accrued Zakat and Tax Liabilities

Other Liabilities include recourse obligations on loans sold to Cagamas. Deferred tax is provided for, using the liability method, on temporary differences at the balance sheet date between the tax bases of assets and liabilities and their carrying amounts in the financial statements. Deferred tax liabilities are recognised for all taxable temporary differences and deferred tax assets are recognised for all deductible temporary differences, unused tax losses and unused tax credits to the extent that it is probable that taxable profit will be available against which the deductible temporary differences, unused tax losses and unused tax credits can be utilised. Deferred tax is measured at the tax rates that are expected to apply in the period when the asset is realised or the liability is settled, based on tax rates that have been enacted or substantively enacted at the balance sheet date.

(i) Derivative Financial Liabilities

The derivative financial liabilities are quoted at their current-fair values as of the balance sheet date of all liabilities resulting from contracts that meet the criteria of being accounted for as Islamic derivative instruments, and which cash flows are separated, monitored and identified carefully to ensure that these cash flows will not be derived from conventional interest-bearing transactions. Otherwise, the bank shall dispose this cash within a year or the normal operating cycle. Because when a longer time is taken for disposal, the net effects of from mastering the netting technique to meet the objectives of separating *Shari"ah* compliant funds from interest-bearing mechanisms will become more difficult.

The non-current Islamic financial derivatives on BIMB"s balance sheet are also at their fair values as of the balance sheet date of all liabilities resulting from contracts that meet the criteria of being accounted for as *Shari"ah* compliant derivative instruments. Similarly, the bank should scrutinised all cash flows related to this instrument because funds derived from non-*Shari"ah* compliant transactions will be disposed in the near term of less than a year from the date on which the transaction is performed or beyond the normal operating cycle. Likewise, if the bank takes longer time for disposal, it would result in the net of the effects of master netting arrangements discussed earlier (GAAP, 2012).

3.9.2.3 Equity

(a) Paid up Capital

The entire issued and paid-up capital of RM100 million is owned by the Government of Malaysia. Tier-1 Capital refers to "paid-up capital, non-cumulative perpetual preference shares, share premium, statutory reserve fund, general reserve fund, retained profits, surplus/ loss arising from sale of fixed and long-term investments as well as minority interests (consistent with the components of Tier-1 Capital) and after deducting goodwill. Since early November 2000, Tier-1 Capital includes audited half year after-tax profits."

(b) Equity: Share Premium

Share premium is the amount received by a company over and above the face value of its shares. Face value of a share is its value that is printed on the share certificate. For example, face value of a MYR1.00 share is one ringgit. A share with face value of MYR1.00 does not imply exactly the market price/value of that share.

Depending on the historical performance of a company, if the company experiences good performance, it will be reflected by its potentially higher market than its face value. This places the pressure on „buy‟ decisions and this pushes the equilibrium price further. The difference between the selling price and the face value of a share is known as share premium.

Tier-1 Capital consists of the paid-up capital, non-cumulative perpetual preference shares, share premium, statutory reserve fund, general reserve fund, retained profits, surplus/ loss arising from sale of fixed and long-term investments as well as minority interests (consistent with the components of Tier-1 Capital) and after deducting goodwill. Beginning of November 2000, Tier-1 Capital includes audited half year after-tax profits.

(c) Retained Earnings

Retained earnings are the profits generated by a company that are not distributed as dividends to the shareholders. The retained earnings are the sum of profits that have been retained by a company since its inception. They are reduced by the losses. Retained earnings are also known as accumulated surplus, accumulated profits, accumulated earnings, undivided profits and earned surplus (Cotter, 2012).

The financial statements for the current financial year do not provide a clear figure of the proposed proportion (or ratio) of dividend payment. If such dividend is approved by the shareholders at the forthcoming Annual General Meeting, it will be accounted for in the shareholders‟ equity as an appropriation of retained profits in the next financial year. Other Influences refer to the net of all other assets and liabilities in the balance sheets of BNM and the banking institutions that cannot be classified in any of the aforementioned categories. Among the major items are paid-up capital and reserves, retained profits or losses of BNM and the banking institutions and. Tier-1 Capital refers to paid-up capital, non-cumulative perpetual preference shares, share premium, statutory reserve fund, general reserve fund, retained profits, surplus/ loss arising from sale of fixed and long-term investments as well as minority interests (consistent with the components of Tier-1 capital) and after deducting goodwill. Since the start of November 2000, Tier-1 Capital includes audited half year after-tax profits.

(d) Other Reserves

Other Reserves is comprised of the Exchange Rate Fluctuation Reserve, the Investment Fluctuation Reserve, the Insurance Reserve and the Contingency Reserve. To provide a breakdown, the nature and purpose of other reserves maintained. The asset liability management model is developed in mathematical programming framework. To have the general formulation, first we need to understand the optimisation problem, that is, the asset liability management of BIMB. Then, in addition to the decision parameters the number of decision points has to be identified. In this thesis, it has been agreed that the decision point should focus on a single period optimisation and that it should not consider the „time value of money" concept as the pricing of such money without being accompanied by equitable efforts and contribution in any form is prohibited in the view of *Shari'ah*. After considering the elements constituting to the single-period framework modeling, process is followed by attention to the formation of other relevant metrics of the optimisation, specifically the penalty cost optimisation. They are the objective or objectives to be optimised and the constraints imposed on this/these constraints. The following part of the thesis is segmented to provide aspects of the model"s formulation concisely. Mathematical representations aspect of this model will be covered later in Chapter 4. The following structure of this section carries the following discussions; Section 3.9 gives an overview of the penalty cost optimisation, Section 3.9.1 describes the objective functions, and Section 3.9.2 a sub-section to brief readers on the set of mathematical constraints of the asset liability multi-objective optimisation model.

3.10 Overview of the Penalty Optimisation Method

In summary, the model supposes that the management are aspired to maximise returns (profits) over a single year planning horizon. Structural elements of the model"s mathematical formulation are detailed in the later sections. The foundation to the formulation of the optimisation objective function is explained briefly in section 3.10.1 and Section 3.10.2 to emphasise the building blocks of constraints formulation. In order to solve constrained optimisation problems the penalty cost optimisation method is used. It is represented by a group of algorithms exercised on constrained optimisation problems. The approach begins with replacements to constrained functions by unconstrained problems that will converge idyllically to example the solutions for the original constraints. Under this method, the unconstrained problems are added and these additional terms are known as the penalty function (as discussed in Section 2.11).

3.10.1 Objective Function

The optimisation problem focuses on the measure of the violation or deviation from expected targets (represented by the constraints) within its objective function. These penalty parameters are augmented into the violation measurement terms. When the values of violation sums to a nonzero figure, it shows that the constraints are violated, and if it sums to zero, then the constraints are not violated. Not only that, the objective function is represented by the cost parameters that should be nonnegative. This is also one of the practical assumptions for the functionality of the model. Thus the baseline objective function of the penalty method proposed by Chong and Zak (2013, pp. 445–453) of asset liability problem is;

Objective: (3.6)

$$\begin{array}{ll} \textit{Minimise} & f(x) \\ \textit{subject to} & g_1(x) \leq 0 \\ & g_2(x) \leq 0 \\ & \vdots \\ & g_p(x) \leq 0, \end{array}$$

With,

$$\begin{aligned} f &: \mathbb{R}^n \to \mathbb{R}, \\ g_i &: \mathbb{R}^n \to \mathbb{R}, \\ i &= 1, \dots, p \end{aligned}$$

$x = \{x_a, y_b\}$

$a = \{1, \dots, 13\}$

$b = \{1, \dots, 13\}$

Where:

$\mathbb{R}^n$ = Set of real data from the balance sheet

x_a = Asset variables from asset type 1 to 13

y_b = Liabilities and Equities items from the balance sheet, 1 to 13

g_i = Multiple asset liability management objectives

p = The last objective of the multiple asset liability management

The penalty optimisation method with reference above is an adaption of the model suggested by Chong and Zak (2013). It represents a baseline function development which can be found also in Smith, Smith, Coit, Baeck, Fogel, and Michalewicz (1997). Basically, there are two fundamental types of penalty functions; the exterior penalty functions and the interior penalty functions. The exterior penalty function penalizes infeasible solutions whereas the interior penalty function penalizes feasible solutions. Mentioned briefly in Chapter 2, Section 2.11, the interior penalty functions require the constraints to be „closely-fitted" that is, it should be a tightly binding constraint. However, in problems where combination between exterior, interior and partial penalty function exists, the combinatorial optimisation is advisable. The method calls for temporarily relaxation of the most difficult constraint(s), through a revised objective function to prevent solutions from deviating too far from the feasible region. Read Chapman and Hall (1974) for more comprehensive understanding on the feasibility and infeasibility solutions in optimisation problems. The baseline penalty function above will be used to minimise the objective gaps of the constraints formulated for BIMB. There are altogether eighteen (with representations by the notations above) objectives in this section.

3.10.2 Constraints

The set of constraints refers to conditions that the solution to the optimisation problem must satisfy. Here, the resource availability should be satisfied among all available classes of assets $x = \{x_a, y_b\}$ with asset allocation as the suggested solution to the bank‟s model. As discussed above, penalty terms are included to measure severity of constraint violation. However, we know that constraints violations are unavoidable since in the math world, arbitrary and ideal situations can be constructed. To the contrary, practical world demands for complex problems and cases that are manifold, making problem solving challenging. We should however bear in mind that pragmatically; constraint violations cannot be oppressed entirely.

Before particularizing the elements of the model, we have to first know in albeit, cash flows occur throughout the given planned horizon, we assume that all cash flows incur at the beginning of a certain planning horizon. The findings from the analysis of simulated results using the model will be detailed in Chapter 4. The conceptual constraints are established in Section 3.10.2.1 to Section 3.10.2.18. Algorithms designed for this process are presented in Section 3.11.

3.10.2.1 Investment Returns Performance

These returns include returns to the bank‟s investment portfolios. Returns generated from *Available-for-sale Securities* are treated under the accounting standards guided by the Malaysian Financial Reporting Standards 9 (MFRS 9). Income from this group of security constitutes part of the bank‟s “Other Comprehensive Income”. Thus the value MYR478,428 million considers other comprehensive income arising from the fair value adjustments made to the “available-for-sale” securities in 2012. The returns function established in Expression 3.7 considers income obtained from the uses of fund net costs associated to the sources of these funds (liabilities and equities). As part of the Expression, inputs on costs associated to the bank‟s sources of fund are presented in Table 3.5. Returns for asset classes $x_1$to x_{13} are annualised expected yields derived from year Q4:2009 to Q2:2013 and averaged based on the number of periods observed. The returns are calculated using formula presented in earlier section (Expression 3.1) for all income generating assets from asset 1 to asset 10 (represented by x_1 to x_{10}) that is cash and other short term near cash liquid assets to Held-to-maturity Securities (See Table 3.4).

Table 3.7: BIMB Cost of Funds for Liability Items

Mathematical notations	Variables	Annualized Costs
y_1	Savings	5%
y_2	SIA	4.95%
y_3	GIA	3.67%
y_4	Term Deposit-i	7.35%
y_5	NIDC, Ziyad, and others	3.25%
y_6	Placements by other institutions	3.25%

Source: BIMB website

This function considers only costs which are affecting the investment returns directly. Indirect cost like the shareholder‟s opportunity costs for capital contributed to BIMB cannot be identified clearly and therefore is not considered. The mean yearly cost of capital is obtained with reference to the information on rates chargeable by the various categories of capital providers, y_1 to y_6 shown in Table 3.7 above. Using information from *Other Comprehensive Income* and the costs of capital for each types of capital above, Expression 3.7 is established. d_1^+ represents gap or variance which is the interest of this study because it implies that there could be possibly an occurrence or event that causes any discrepancy between the actual and expected outcomes. Chapter 5 explains this discrepancy with justifications and comparisons based on performance reports by BIMB to explain the implication of this discrepancy or gap on BIMB‟s performance.

$$\left[0.0274x_1 + 0.0633(\sum_{i=4}^{7} x_i + x_2 + x_{10}) + 0.075x_3 + 0.0346x_8 + 0.04x_9\right] - [0.05y_1 + 0.0495y_2 + 0.0367y_3 + 0.0735y_4 + 0.0325y_5 + 0.0325y_6] - d_1^+ = 478428 \quad (3.7)$$

3.10.2.2 Capital Adequacy

The capital adequacy requirement represents the function of the Islamic bank‟s jurisdiction on reserves for the worst case scenario and economic fluctuations. It provides a guideline to banks in operational, market and credit risk management. Data consisting capital adequacy requirements for Islamic banking institutions in Malaysia can be obtained from BNM/RH/GL 007-21, Capital Adequacy Framework for Islamic Banks (Risk Weighted Assets), with subsequent pages noting the capital adequacy guideline for Islamic banks. Islamic banking institutions are allowed to use their own internal rating based (IRB) approach in credit risk weighting methodologies, yet, under the framework, there will be a capital floor in which the Islamic banks must gage the difference between the following sets of items (BNM, 2012);

For baseline capital established using the standardised approach, the following adjustments should be done;

1) 8% of the Risk Weight Assets (RWA) under the current requirement, plus Tier 1 and Tier 2 Capital deductions, less General provisions that are recognised in Tier 2 Capital;
2) RWA is included in the model according to the weights allocated to the assets following the guidelines issued by the central bank.
3) The capital ratios used as part of the model is shown in Section 4.2.2, Table 4.5.
4) Formula in Expression 3.4 is then used to calculate the common equity tier 1 ratio (Table 3.8 provides the types of ratings investment and risk weights assignment to different classes of assets. Expression 3.8 below is a formulation of the capital adequacy constraint function with reference to the requirements under BNM/RH/GL 007-20).

Table 3.8: Investment Ratings and Risk weights

Investment Ratings	AAA to AA-	A+ to A-	BBB+ to BBB-	BB+ to B-	CCC+ to C	
Risk weight	0%	20%	50%	100%	150%	100%

Source: Bank Negara Malaysia, Capital Adequacy Framework for Islamic Banks (Risk Weight Assets), p.13

In addition to the risk weight table (Table 3.8) detailed above, the framework provides a risk weight of 125% will be assigned to investments in equity for non-financial profit-making subsidiaries, investment in general business enterprises will be assigned a risk weight of 150%, assets not specified in the framework will be risk-weighted at 100% and that the maximum for all these risk weights should not exceed 1250% (for the riskiest assets). Combining the above weights, the conceptual capital adequacy constraint is presented in Expression 3.8.

$$\sum_{j=10}^{13} y_j - 0.08\left[0 \times (x_1 + x_8 + x_{12}) + 0.2\left(\sum_{i=2}^{7} x_i + x_9\right) + 0.125(x_{10} + x_{11}) + x_{13}\right] + d_2^- - d_2^+ = 0 \tag{3.8}$$

3.10.2.3 Liquidity

In order to operate in a sound operational environment, liquidity risk management is crucial for the Islamic bank. The bank must have a robust and efficient liquidity management framework. This framework is an important yardstick to the bank‟s funding and investment activities. Given such effort to promote liquidity management in Islamic banking institutions, Bank Negara Malaysia introduced the Liquidity Framework in 1998 to replace the liquid asset ratio requirement. These liquidity ratios set indicators that will force banks to hold more short and long term funding. The liquidity coverage ratio and net stable funding ratio is referred to provide guidance in understanding how the stock of highly liquid assets corresponds to factors within the model. This also ensures that the bank has enough capital reserves to meet rigorous withdrawals during unfavourable economic conditions. Additionally, the constraint follows the capital adequacy reserves formula by Bank Negara Malaysia. Expression 3.9 provides that BIMB must ensure sufficiently the availability of highly liquid asset (x_1) to cover liquid obligations (y_1- y_5). There could be performance slacks or variance when the expected result is compared to the actual performance. The implication of this variance is discussed in Chapter 5.

The Liquidity constraint is developed according to the guidelines provided by the central bank in BNM/RH/GL/002-12 on Liquidity Framework (see Expression 3.9 below).

$$x_1 - 0.01\sum_{j=1}^{5} y_j + d_3^- - d_3^+ = 0 \tag{3.9}$$

3.10.2.4 Total Assets Growth

The highlight on constraints development continues with the total assets growth policy by the senior board managers in BIMB. The policies are determined by analysing the financial ratios in Chapter 4 along with commentaries of reports produced by the third independent party of Rating Agency Malaysia Holdings Berhad (RAM) for BIMB in years 2010, 2011, 2012, 2013 and 2014 (general comparison between financial institutions in Asia). The bank‟s performance on an overall year-to-year bases has improved by 31% to RM3.2. The figure represents total assets growth as at June 2013. The growth was mainly supported by increased in financing assets spurred by the bank‟s Sustainable Growth Plan in 2012 (RAM, 2013). Denoting all assets as x_i with $i = 1,2,\ldots,13$ and the objected growth gathered from RAM (2013)‟s report, we have the following constraint in Expression 3.10.

$$\sum_{i=1}^{13} x_i + d_4^- - d_4^+ = 47146591 \tag{3.10}$$

3.10.2.5 Total Deposit Facility Provision

One of the provisions of the Act requires all Islamic Banks to re-classify their existing deposit products based on the underlying *Shari"ah* contracts. This re-classification is scheduled to take effect on 1 July 2015. Under the IFSA 2013, all existing Islamic deposit products that apply the *Shari"ah* contracts of *mudaraba*, *musharakah* and *wakalah* are now classified as investment products. BIMB intends to fulfil the IFSA requirements and has been taking serious measures to ensure compliance within the stipulated timeframe. As the first pillar of the half year of the second quarter plan, robust organic growth necessitated the achievement of annual targets established for the next three years. However, demanding developments during the year under review – domestic and global economic challenges, fierce competition and the implementation of macro-prudential measures by Bank Negara Malaysia to address increasing household debt as well as the new classification of deposits under IFSA 2013. From Expression 3.11, one can tell that the summation of the total obligations from y_1 to y_6 must be equal to at least 25% less fund allocation for investment and funding assets (x_2 to x_{10}) so that the marginal resources derived from this approach can be channelled to investments catered to enhance the number of deposit facilities available to BIMB customers.

$$\sum_{i=2}^{10} x_i - 0.85 \sum_{j=1}^{6} y_j + d_5^- - d_5^+ = 0 \qquad (3.11)$$

3.10.2.6 Total Return to *Mudaraba* Investors

The *mudaraba* investors can also withdraw their funds on demand. In order to satisfy these withdrawals, the central bank placed a minimum capital adequacy on the bank"s funds. As owners of the *mudaraba* capital, they are entitled to returns according to their percentage of funds contribution. Mentioned in previous chapter, the *mudaraba* investors are treated as owners, whereas acting as „entrepreneurs", the bank should invest these funds with their expertise to maximise the *mudaraba* investors" wealth. Profit gained from this effort is to be shared according to an agreed rate between the two parties. BIMB"s *Mudaraba* General Investment-i are categorised under the following maturity terms and therefore, returns should also be prorated according to these investment periods; 1, 3, 6, 9, 12, 18, 24, 36, 48 or 60 months (BIMB, 2013).

$$y_3 - 14.73mil \leq 0 \quad (3.12)$$

3.10.2.7 Sources and Uses

This constraint places cash inflows and outflows to be equal. In practice, excess funds are used for investments either in the long term or short term investments. The long term assets could include stocks or Islamic bonds (*Sukuk*), a non-current asset whereas the short term investments could include Islamic Interbank Money Market securities, cash, and other liquid investments.

A talk by Dr. Ruqaia a member of the Ira House of Representative on 15 or March 2012 in BIMB provided a clear picture on the sources and uses of funds for the Islamic bank. Figure 3.2 shows the diagram on the sources and uses as well as the flows of these funds from one to another channel of fund. It is observed here (backed by her speech), that the sources and uses of funds between the general pool of funds, funds from Specific Accounts 1 and 2 are non-divisible. Separating these pools of funds to their actual channels of uses will produce spurious amount of input and output cash flow amounts when compared to reality. Though various attempts were considered by the researcher (i.e. analysing the cash flow statements) to determine these amounts – specific values to sources (the shareholders" capital, *mudaraba* non-*mudaraba*) and assigning them to their specific uses (operational expenses, investments, loans and so on) were challenging. Therefore, in order to establish Expression 3.13, we have to assume that the pool of funds between these liabilities and equity classes are non-divisible and should be grouped. Additionally, the uses of these funds will be to all the assets from cash and near cash items to securities held-to-maturity. With this understanding, Expression 3.9 for constraint „sources and fund" is established.

$$\sum_{j=1}^{6} y_j + \sum_{j=10}^{13} y_j - \sum_{i=1}^{10} x_i = 0 \tag{3.13}$$

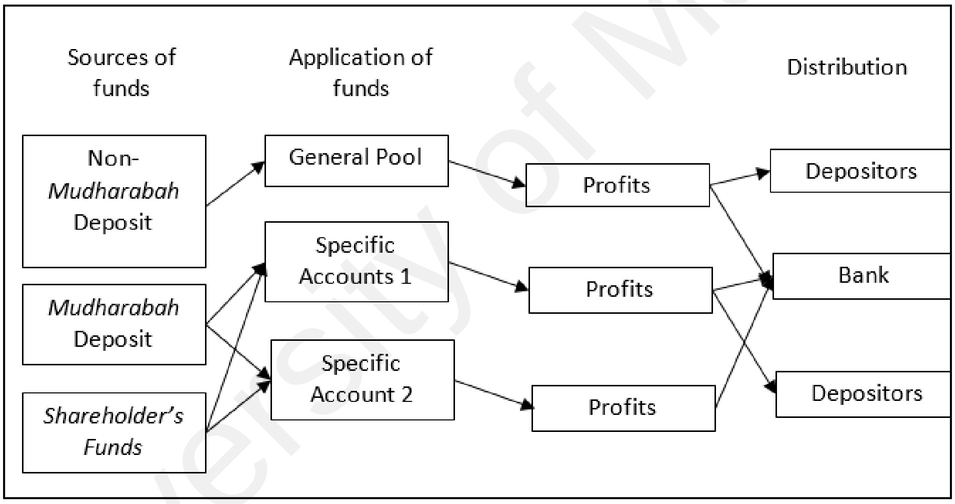


Figure 3.2: Sources and Uses of Funds in an Islamic Bank
Source: Ruqaia (2012); Understanding Islamic Bank Balance Sheet

3.10.2.8 Legal Deposit Risks: Withdrawal risk

The statutory deposit threshold is kept to maintain liquidity. Tabung Haji has consistently been among its largest depositors (RAM, 2013). It represents the cash reserves that banks must hold in good investments (also viewed as higher credit rating investments). The central bank requires all banks, including Islamic banks to hold a threshold funds not less than 17% of the amount reflected in the bank"s total equity.

Chambers and Charnes (1961) and Cohen and Hammer (1967) have justified the use of linear functions to model a bank‟s asset and liability management problem. Thus from the point of view of linearity, the appropriateness of using linear programming under uncertainty, is established. The asset and liability management problem fits well as a stochastic linear programming with simple recourse model. Effective 16 July 2011, the Statutory Reserve Requirement (SRR) rate for banking institutions is 4% of eligible liabilities (EL). As per the requirements in the Liquidity Framework, this shall be 3% and 5% of total outstanding deposits for ≤1 week and 1 week to 1 month buckets respectively, or any other rate/amount agreed with the Bank.

$$0.03\sum_{j=1}^{6} y_j \leq x_1 \leq 0.05\sum_{j=1}^{6} y_j \tag{3.14}$$

3.10.2.9 Statutory Reserve Requirement

$$x_{12} \leq 0.03\sum_{j=1}^{6} y_j \tag{3.15}$$

Islamic Financial Services Act (2013) refers *zakat* (Islamic tax/ levy) as alms giving. Earnings after tax and *zakat* not distributed to the shareholders in the form of dividends will be held as retained earnings. These retained earnings after *zakat* and tax is non-binding leads to surpluses (earnings to be used for business opportunities). Effective 16 July 2011, the Statutory Reserve Requirement rate for banking institutions is 4% of the eligible liabilities – liabilities that are usually maturing at a very near term (See BNM/RH/GL 007-1: Statutory Reserve Requirement issued by Bank Negara).

This requirement took effect in July 2011. It is applicable to Islamic Banking and Islamic insurance) *Takaful* institutions. This should be accounted for within the hard constraint function of the optimisation model. BIMB is revising its Base Financing Rate (BFR) from 6.30 per cent per annum to 6.60 per cent per annum with effect from 16 May 2011. BIMB Managing Director, Dato‟ Sri Zukri Samat said the rate revision was due to the rise in Bank Negara Malaysia's Overnight Policy Rate (OPR) by 25 basis points to 3.00 per cent and SRR ratio to 3.00 per cent. The last revision in BIMB‟s BFR was on 13 July 2010 when the rate was revised from 6.05 per cent to 6.30 per cent. The rates, the rate which serves part of eligible liabilities and other financial information related to earnings after tax and zakat for year 2012 and 2013 will be taken to form the constraint function representing requirement to put aside an amount of funds for this purpose.

3.10.2.10 Balance Sheet Equality

$$\sum_{i=1}^{13} x_i - \sum_{j=13}^{13} y_j = 0 \qquad (3.16)$$

Expression 3.16 takes the form of equality and it is binding. This expression requires the total assets to equal to the sum of all liabilities and equities. It is reflective of the rules of book keeping according to the matching concept in accounting to show that the assets are financed by capital in the form of liabilities and equities. The accounting principle relevant to Expression 3.16 is available in the International Accounting Standards Board (IASB) (Elliott, and Elliott, 2007). The function presents all assets, liabilities and equities on BIMB‟s balance sheet.

3.10.2.11 Structural Cash Requirement

$$0.2 \times \sum_{j=1}^{6} y_j - x_1 \geq 0 \qquad (3.17)$$

$$Liquidity\ Coverage\ Ratio = \frac{Highly\ Liquid\ Assets\ Reserves}{Total\ net\ cash\ outflow\ for\ the\ next\ 30\ days} \qquad (3.18)$$

Liquidity Coverage Ratio (LCR) in Expression 3.18 is a quantitative requirement which seeks to ensure that banking institutions hold sufficient high-quality liquid assets (HQLA) to withstand an acute liquidity stress scenario over a 30-day horizon. LCR is applicable to all banking institutions. BNM issued its “Liquidity Coverage Ratio” guideline on 30th September 2014. A banking institution shall calculate its liquidity coverage ratio in the following manner;

Calculation methodology is shown in para 8.2 of the “Guidelines for Islamic Bank Liquidity Risk Management” as; here the ratio is calculated as 0.2. Total cash outflow is taken by referring to the maturity bucket of cash up to one month for deposits y_j where $j = 1,2, \ldots ,6$. The total for this value is obtained from the bank‟s 2013 annual report in the notes. Then, this figure is taken as the denominator for the total assets value under cash holdings (x_1).

3.10.2.12 Investment Account Holder’s Profit Sharing

$$x_1 \leq 0.03(y_3) \qquad (3.19)$$

The prorating and percentage of returns distribution between the ‚profit sharing account‟ (*mudaraba* and *musharakah*) holders is done by referring to Paragraph

30.2: BNM/RH/STD 029-4. Paragraph 30.2 outlines the standard methods for calculating the rate of return and profit distribution to the investment account holder (IAH). Profit distributable to the Investment Account Holders is determined by the pre-agreed terms and profit ratios shared between the bank and the accountholders. Similarly, the updated guideline by Islamic Financial Services Act 2013 states that this policy provides the recommended technique for returns to BIMB (para. 1.3).

The net distributable income represents the apportionment of the net distributable income between the IAH and the Islamic bank according to the terms of the investment account. Included under Appendix 3 of the Guideline, a table showing distribution the two types of investments account based on *mudaraba* and *musharakah*. To illustrate this, let us take a single period rate of return example with profit sharing ratio of 75:25, 75 per cent of the returns distributable to the Investment Account holders and 25 per cent for the Islamic banks implies that the Islamic bank is required to maintain a total amount of MYR59.3 for distribution if the bank generates a total return of MYR79.07 from the pool of Investment Account funds. The methodology for calculating income attributable to the depositors can be found in Appendix 3 of the guide.

3.10.2.13 Investment in Entrepreneurial (*Mudaraba*) Investments

$$x_2 + \sum_{i=8}^{10} x_i - 17782 \geq 0 \tag{3.20}$$

Business Financing-i by BIMB is issued using the *bi'bithaman ajil* contract. Other bank offering similar product is AmIslamic Bank with a different branding image under Project Financing-i. This type of arrangement involves *wakalah* (agency) contract which refers to an agency relationship where one party is appointed to act as an agent on behalf of another party. The profit sharing rate has to be mutually consented upon and explicitly stated at the time of contracting (*aqad*) and has to be in proportion/ percentage terms of the profits. In a reverse condition where a financial loss occurs under the *mudaraba* financing, the Bank will bear the loss. There are two types of *mudaraba* under this scheme. They are the Restricted *Mudaraba* (*Mudaraba Muqayyadah*) *and* Unrestricted *Mudaraba* (*Mudaraba Mutlaqah*).

3.10.2.14 Charity Policies

$$0.3\sum_{i=2}^{7} x_i + \geq 597380 \tag{3.21}$$

Thirty per cent of the customers‟ credit card transactions during *Ramadhan* will be channelled for charitable activities. In the *Qur'an* "That which ye lay out for increase through the property of (Other) people, will have no increase with *Allah*: but that which ye lay out for charity, seeking the countenance of *Allah* (will increase):

"*It is these who will get a recompense multiplied*" (*Qur'an* 30:39).

This information is available in BIMB‟s general management thoughts and future direction website. BIMB also undertakes a yearly campaign for *Amal Jariah* /Charity Program via its credit card. The *Amal Jariah* donation came from 0.3 per cent of the bank's customer credit card transactions during *Ramadhan* (BIMB Annual Report, 2013; p. 27).

When earnings from non-*Shari'ah* compliant income is identified, the Bank is obliged to dispose the *Shari'ah* non-compliant income by way of charity as soon as possible (mentioned in earlier section was about the period of disposal suggested by the central bank – less than 12 months). *Shari'ah* non-compliant income must be placed in a special account (2.5% contribution to *sadakah* or *Zakat*). The bottom line is that the poverty reducing strategy needs to set aside a set of resources not only to counter the negative effect of macroeconomic policies on the poor in the short run but also to serve as safety net when the risk factors are in action.

Zakat is a pure Islamic religious obligation. Muslims are required to treat this commandment as habitual obligations similar to the daily fulfilment of five time prayers to God. To the Islamic financial institutions, this commandment is performed to promote social wellness by ensuring the wellbeing sustenance of the economically deprived group of the economy. It acts as a catalyst to bridge economic gap between the wealthy and the poor. Here, *Zakat* (lèvy) is distributed in various forms such as money for food, clothing, longing, shelter to the needy. *Zakat* in fact is an obligation with broad features reflecting the religious codes in Islam as the way of life known as *Sadaqat* or *Infaq* or "spending for good causes". The teachings of Islam lay tremendous emphasis on spending in the way pleasant to the eyes of God out of one's own resources. *Zakat* is a minimum obligation under this broad injunction. There is no upper limit to this spending to thwart the growth in the economy.

3.10.2.15 Funding Policies: Impaired Financing Management

$$0.014\sum_{i=2}^{7} x_i \leq 19507.8 \qquad (3.22)$$

Total financing, advances and others reported at the end of December 2012 for BIMB is RM19,507,799, hence the formula above. Expression 3.22 provides that BIMB, according to its operational policies experiences a total amount of funding policies to cover 1.4% of the bank‟s impaired financing from asset x_2 to asset x_7.

On the back of robust financing growth coupled with a still declining base of impaired financing, BIMB‟s gross impaired financing ratio had eased further to 1.4% as at end June 2013 (which was taken before the revised financial year end calculated as the last day of December 2011: 2.6%). This was better than the overall banking system‟s average of 2.0%. The research analysed 5-year impaired financing ratio of BIMB to justify the impaired financing account management strategy by observing the relative increase or decline in this ratio as a percentage of the total financings given out by the bank. A type of asset quality indicator (formula) that is "Total Impaired Financing" divide "Gross Financing and Advances" is used by the Ratings Agency Malaysia (2013, p. 14) to calculate the following ratios by averaging the industrial returns in percentages. They are 2.0% in 2013 and 3.4% in 2010 (RAM, 2013, p. 5). Whereas, the end of period total impaired financing are RM308.71 million for year 2012 and RM298.03 million and for year 2013.

Internal *Shari"ah* complying policies charted a 19% financing growth in financial year ending 31 December 2011. BIMB‟s internal *Shari"ah*-compliance policies aim to ensure that the Bank‟s products, services and activities comply with *Shari"ah* requirements, as determined by the various *Shari"ah* regulatory councils. The recovery management committee oversees the recoverability of the BIMB‟s legacy financing performance as reported by RAM Holdings, besides assessing the recovery prospects of more recent disbursed financing. Impaired asset over non-performing loans ratio reflects the bank‟s non-performing loans management. (Source: Ratings Agency Malaysia (RAM), a third parting credit rating agency).

3.10.2.16 Risk-Asset Objective: Credit Line

$$1.2x_7 + 1.0x_8 + 1.2x_9 + 1.4_{10} \leq 0.5\left[\sum_{j=1}^{6} y_j + \sum_{j=10}^{13} y_j\right] \tag{3.23}$$

A research by Kumar and Leonard (1988) was carried out to investigate the riskiness of each *Shari'ah* contract like *murabaha*, *mudaraba*, *musharakah*, *ijara*, *istina*, *salam* and diminishing *musharakah* (*Musharakah Mutanaqisah*). First Expression represents credit risk, the second reflects market risk, (3) liquidity risk, (4) Operational risk (Kahf and Khan, 1992). Expression 3.23 is derived by taking the proportion of not more than 60% of the total funds to fixed term loans, personal vehicles and assets financing (Sulemana and Haadi, 2014; p. 31). It is observed that BIMB has reduced their market share in providing risk-asset financings in 2012 to 2013 by 8% that is, from 58% to 50% (RAM, 2013, p. 3).

3.10.2.17 Solvency Management: Financing-to-Deposit

$$0.7 \leq \left[\sum_{i=2}^{7} x_i \div \sum_{j=1}^{6} y_j\right] \leq 0.8 \tag{3.24}$$

Management"s optimum financing to deposit ratio is between 70% and 80% (RAM, 2012, p. 9). BIMB"s financing-to-deposits ratio came up to a low 42% as in Q4 2010. BIMB boasts a favourable liquidity position and commendable funding profile, with an exceptionally low financing-to-deposits ratio of 57% and a considerable proportion of low-cost deposits. Similar formula of the Expression 6.20 can also be obtained from Saunders, Cornett, and McGraw (2006).

A commonly used statistic for assessing a bank's liquidity is by dividing the bank‟s total loans by its total deposits. This number, also known as the long-term debt ratio, is expressed as a percentage. If the ratio is too high, it means that banks might not have enough liquidity to cover any unforeseen fund requirements; if the ratio is too low, banks may not be earning as much as they could be. It represents leverage management policy and analyses data from the past 5 years. The ratio is written as;

$$\left[\frac{Customer\ deposit}{Total\ funding\ excliding\ derivatives} \times 100\%\right] \qquad (3.25)$$

Funding-to-deposit ratios obtained for the following years are shown in Table 3.9 below;

Table 3.9: Five Years' Financing to Deposit Ratios as at the End of June

2013	2012	2011	2010	2009
61%	57.02%	50%	42%	38.33%

3.10.2.18 Non-Negativity Constraints

$$d_i^+, x_a, y_b \geq 0 \qquad (3.26)$$

Prohibition of short selling by *Shari'ah*: This section describes the concept of short selling and implementation to capital marketing (Wajdi and Dusiki, 2008). In conventional capital market, there is an instrument that allows investors to make money without actually owning any shares. This instrument is commonly known in equity market as short selling. In Malaysia, Bursa Malaysia (Stock Exchange of Malaysia) defines Regulated Short Selling (RSS) as: "the selling of approved securities where the seller does not, at the time of the execution of the sale, have an exercisable and unconditional right to vest such securities in the purchaser but has, prior to the execution of the sale, executed an agreement to borrow the approved securities as will enable delivery of the same to be made to the purchaser under the said sale, in accordance with the Rules relating to delivery and settlement” (Bursa Malaysia, 2006).

Bringing forth the above *Shari'ah* concept the above, there is another proverb fundamental to justify the prohibition of short-selling in Islam. The quote states: "All exchanges (with the exception of *ibadah*) are reasonable (*ibahah*) unless there is clear proof from the sources (*Qur'an* and *Sunnah*) that precludes them". Besides, an exchange is substantial from the *Shari`ah* viewpoints when it doesn't disregard a definitive standard. This implies that an exchange must occur in the first place of transaction not after the fact that it has been precluded beyond or above the current market price when such need (henceforth agreement) occurs. Trade power may likewise give system to settlements of question among exchanging individuals, and thus understanding to destinations of *Shari`ah* (*maqasid*).

Also, the short selling is not encouraged because some margin trading with short selling features allows the margin account holders to take their stocks account as collateral for additional trading credits. This will encourage more debts on non-tangible assets such as stocks (a financial instrument). In order to facilitate growth in an active economy Islamic finance permits that stocks fulfilling the homogeneity (*mithli*) properties in which all legal advisers, including the *Hanafis*, consider as an imperative foundation for items to be qualified for loaning. For whatever length of time that the basic topic that the stock speaks to is legitimate (*halal*) from *Shari`ah* domain, the stocks can be a topic of an advance contract. In this manner the reasonability of controlled short offering ruled by *Shari`ah* Supervisory Council of Malaysian Securities Commission requires revaluation.

This is based on an investigation account by the Council that probed the case under which issued *bay` ma`dum* (a contract involving transaction of a sale without goods like the conventional financial derivatives. This transaction does not require the exchange of goods when the ownership of such contract is transferred to a third party, usually a risk taker (Ghazali, 2011) while disregarding potential issues derived from the negative impact of *riba*. The *riba* component is clear in the short offering exchange whereby a stock proprietor gets a two for each penny return on loaning at least 50,000 shares to a focal loaning pool as stipulated in the new control of short offering in Malaysia. Nevertheless, it is near impossible to determine from BIMB‟s financial reports the percentage or number of stocks paid-up and issued, used as collateral for this purpose. Moreover, it was not mentioned clearly if the bank is involved in the short selling activity.

3.11 Algorithm

Before continuing with the steps taken in modeling BIMB‟s asset liability management problem, it is helpful to first have a brief idea about the process involved through an illustration using the decision support system (DSS) diagram in Figure 3.4 (page 210). In short it is known simply as a flow chart of processes in decision making. This procedure is common in operational research. It also provides a rough idea to the readers on what steps were taken by this research to simulate the asset and liability management model using MATLAB. The algorithm chart starts with the execution of the asset and liability management process at time t, where $t = 2012$ and 2013. Inputs consisting of financial information for asset, liability and equity parameters (See Section 3.8.2) are fed into the system with reference to the formulas developed in Section 3.9. These balance sheet data are in captured in the form of matrices[42]. Data solicited from the bank"s balance sheet for both years 2012 and 2013 were presented in We discussed in Section 3.9 and Table 4.5 on the use of financial information and ratios for the development of the functions above.

Financial ratios were taken to aid strategic and operational asset liability management strategies. These strategies are presented in mathematics expressions in Section 3.9. The data was filtered using Microsoft Excel concurrently in order to detect errors that could be due to data collection. This can also be done by performing dispersion analysis through data range and deviation from the sample"s mean. Once the data is readied, it is used as part of the constraints argument input, both the binding and the non-binding constraints. Arguments using MATLAB codes (m-codes) were also input with reference to the theoretical model, that is, two stage optimisation programming (or according to Kuzy and Ziemba (1986), optimisation with second recourse) were performed. The m-codes for the above programming purpose are shown in Appendix B. Then, the MATLAB programming codes were run to test the model. Should the constraints be violated, error checks were administered. To validate the balance sheet optimisation, feasibility check using „check feasibility" function and „estimate bounds" in MATLAB to validate the portfolio"s object (assets and liabilities set) and the global constraints validity were conducted.

The processes were repeated with data filtering and thorough error verification until all constraints (the hard, or also known as the binding constraints) were satisfied. Using the programming codes again, solution that optimises the bank"s portfolio returns whilst satisfying the global constraints was established. This consists of a set of recommended optimal assets mix (asset allocation). Upon completion of the model"s verification, it is used for sensitivity testing to test changes in the bank"s

[42] Refer to Appendix B

portfolio returns within 99% confidence level unto the market rate"s 100 basis point movements. This is done to examine the resulting impacts on the bank"s future earnings. The stress testing will help analyse the likelihood outcome of each to economic condition to enable the management"s contingency plans.

Before modeling these findings, it is important to understand the importance of mathematical assumptions. Assumptions in modeling are the most important stage in mathematical formulation (Miwa, 1986, p. 401). These set of assumptions are based on methodical control over certain decision variables or factors and to abandon insignificant particularities in the problem concerned (Miwa, 1986, p. 402). Although so, we should be cautious to retain qualities that are essential to the optimisation problem to maintain the assumptions reasonableness. This thesis took an additional effort to verify the assumptions above assumptions through literature analysis on optimisation studies, interviews with industry"s experts like the head of the treasury and the head of the *Shari'ah* departments for clarification and validation of theories and approach with a statistician from public universities in Malaysia. Section 3.11 below details all assumptions relevant to the modeling tasks of this research. Figure 3.3 uses *fseminf* search function (also in Appendix B) to find the local maximum from a global minima (See Expressions 3.2). This process is presented in algorithms suggested by MathWorks© and more generally in mathematics representations by Chong and Zak (2013).

It starts with the model (in the form of guided financial information inputs into the mathematics environment in MATLAB R2012b, following strictly the mathematics representations presented in Section 3.9. The process continued with optimal weights identification using interpolation technique for a local maximum. This process requires only one iteration to solve the *fmincon* (target gap minimisation), consistent with the penalty cost minimisation approach. If this iteration criterion is not met, the system will go back to error identification and checks performed to determine and update the constraints developed for the study. This process will continue until all criteria are satisfied. The outcomes of this approach are a set of weights satisfying the optimality objectives for an optimal multi-objective asset liability management.

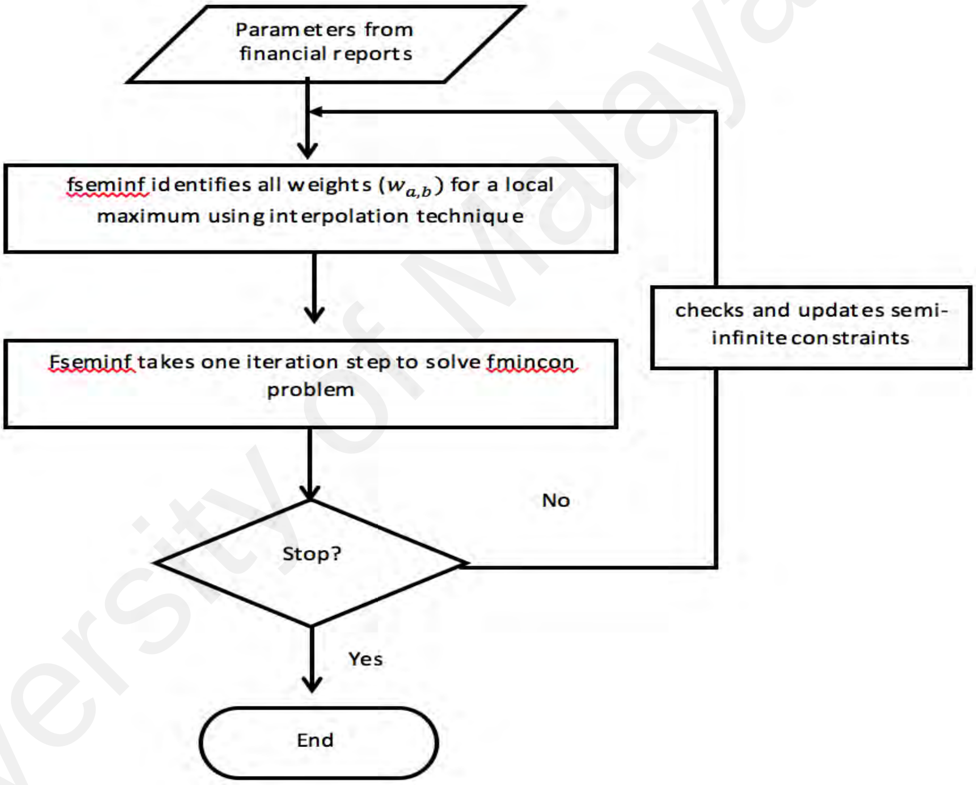


Figure 3.3: fseminf Algorithm

Source: Adopted from MathWorks© and modified for the thesis

An overview of the processes involved for the output of this thesis can be seen in Figure 3.4 (on page 210) the asset liability algorithm for Research Objective TWO (2) of the thesis. Besides the asset liability optimisation model, the thesis is also aimed at developing and documenting algorithms served as reference for all the processes undertaken in generating a set of optimal asset, liability and equity weights.

Figure 3.4 begins with parameters (financial information captured in mathematic expressions) with reference to the penalty method discussed earlier.

This process begins at time t with ratios obtained in Section 4.2, on ratio analysis. Necessary adjustments with proper data cleaning methods and filtration, data input stage – to the system for processing (to capture the binding and non-binding constraints developed in Section 3.9.3. If these constraints are satisfied using penalty methods in optimisation within the computational mathematics environment, then the subsequent stage of data processing is performed. In this stage, the efficient set of portfolio weights for the assets, liabilities and equities corresponding to optimality is obtained to fulfil Research Objective THREE (3) of the thesis. These weights are then used as returns calculation, common size ratio analysis and a benchmark weights (suggestion on portfolio of the BIMB‟s balance sheet items allocation) for year 2012 and 2013.

If these criteria are not met, data filtration, validation, error detection will be repeated until the model converges (See Convergence Theorem in Section 3.3). The model check will also be performed to observe if the model converges (Section 3.3). This approach is taken as the step to validate the multiple-objective asset liability management optimisation model (See Figure 3.4 below).

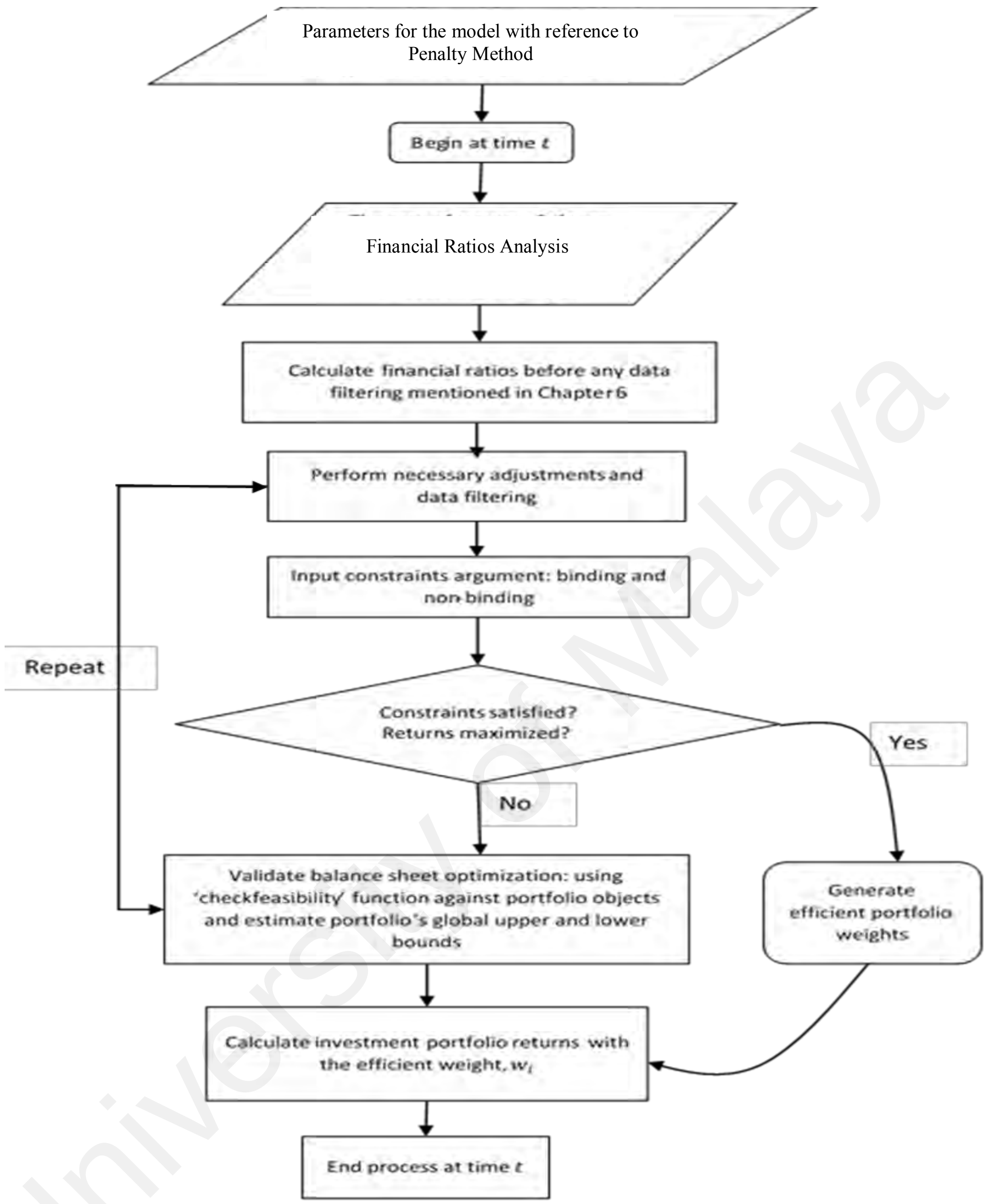


Figure 3.4: Asset Liability Management Algorithm
Source: Developed for this thesis

3.12 Assumptions Enabling the Model's Pragmatism

The current model works based on a few assumptions. According to the literature, different assumptions bring different impact on the final results. This could also mean material effects that would lead to wrong decision making based on erroneous suggestions. The lists of assumptions included below are crafted carefully to suit the Islamic banking operating environment. It is formed based on current studies analysis and implications to it were rectified by seeking professional advice from experts in the field[43]. Aiming to promote the usefulness of the asset liability optimisation, assumptions followed by this paragraph must be introduced.

The first assumption for the model‟s feasibility is that BIMB acts as an economic entity which main objective is profit maximisation. Putting this clearly, we assume that the bank will act based on its good faith to carry out any duty, with good intention to bring wealth maximisation to its owners. As such, the bank will work upon and/or run any activity that is consistent to its shareholder‟s wealth maximisation, including the optimisation of assets and liabilities management. Although the research is built on the foundation of multiple objectivities it is aimed at maximizing the returns of investments, which ultimately contributes to the wealth of the shareholders.

The current research advances the model by including the maximisation of all „equity‟ capital contributors (those including Investment Account Holders) as part of the wealth maximisation objectives. Decisions relating to inclusion of the interests of Investment Account Holders were mentioned earlier in the previous chapters. As part of the research objectives, it is not the intention of the current research to weight the riskiness of each investment instrument as well as the liabilities involved. Keeping this in mind, the second assumption applicable to this model is that the bank employs a standardised method in assessing and managing all investment assets. They are *murabahah* (mark-up sale), *ijara* (lease), *mudaraba* (a type of profit-sharing partnership between the investor and the entrepreneur), *musharakah* (joint venture), and so on (Haron and Wan Azmi, 2009). Other than these, the third assumption needed to ensure

[43] The researcher consulted a university professor in from the math modeling field who is an expert in the area of portfolio management. The success of this research is very much owing to the contribution of this respectful individual who would remain anonymous. Information relating to this can be provided upon request.

the model‟s feasibility is that there are only two types of investments in general classified under as (1) *mudaraba* and (2) non-*mudaraba* deposit accounts. As for the methodology in „equity‟ fund provider recognition between the *mudaraba* depositors (i.e. Specific Investment Account Holders and General Investment account holders) only the General Investment Account Holders are included. This is because there is no clear distinction in the way both types of funds are mobilised (Refer Section 3.9.3.6, Figure 3.2). In short, only the General Investment Account Holders are considered as the „equity-like‟ capital providers in this research.

However, in future researches, this should be noted in the attempt to evaluate wealth maximisation objectives for the two types of equity fund providers. As mentioned in Chapter 2 (along with probable justifications) it is the objective of this research to focus only on a single period planning horizon. Theoretically, the time value of money concept cannot be applied in Islamic finance if we consider that the lenders should be compensated for liquidity (or maturity) risk undertaken in longer period investments. In practice, however, when forgone opportunities of industries with similar projects or investments were considered, expected cash flows are discounted with the rates which incorporates a representative risk metric (asset beta) to reflect the estimated net cash (after risks considerations). The fifth assumption to the model is that the funds are segmented based on two maturities; short term and long term horizons.

Investments classified under the short term horizon are those available in the InterBIMBic Money Market Securities held less than one year maturity. Contrariwise, long term securities are held more than one year. Examples of the *Shari‟ah* complying capital market investments are stocks issued by *Shari‟ah* complying firms and long term Islamic bond (*sak* or *Sukuk* (plural), for those with more than 12 months maturity). Although concerns for liquidity and how this concept is viewed differently across industries (i.e. less than one month maturity is viewed crucially by banking and finance institutions, considering that they are part of the funds centralism or cash management business in nature rather than constructions or property investment driven).

To avoid complications in modeling, we assume that this serves as part of the clear distinction between investment horizons, short and long, both based on the research term by definition, using 12 months as the separating operational descriptions. All returns should be considered net *zakat* and tax. This is one of the most crucial sixth assumptions (contrary to the suggestions by Belouafi (1993)). The reasons were *zakat* is seen as a mean to contribute to societal development from a profit making centre like the bank, ploughing returns earned from the society, through contributions back to the people they serve. A research by Abdullah and Suhaib (2011) documented that *zakat* is not only seen as a mandatory deduction before profit distributions (in terms of dividends) back to the shareholders, it is also seen as a crucial foundation of stability among the *Muslims* society. The seventh assumptions applicable for the model"s feasibility is, fixed assets are constant over the periods concerned. For example, during year 2012, the non-current (or fixed assets) are assumed to be constant (although not really the case practically). This is imposed to avoid complication in modeling the constraints later in the chapter.

Additionally, the paid-up-capital is assumed to stay constant over the planning horizon, suiting the above modeling intentions, as the seventh assumption. Besides, the eighth assumption holds that returns are taken as mean returns rather than absolute returns. These absolute returns are also assumed to be static for the stated periods of interest (Chen, Ju and Miao, 2014; Belouafi, 1993). The ninth assumption notes that there is no cost to financial transactions. These include borrowing, lending and investment activities (Bichuch and Sircar, 2014). Bichuch and Sircar (2014) stated in their work that when the returns volatility is assumed constant, historical transaction costs taken to generate costs forecasts using asymptotic approximation will be small. Therefore, within the no transaction costs stochastic environment an optimised investment problem can be analysed with the use of Merton problem. Here, we can take the return-before transaction costs to for the model.

Lastly, the model assumes the non-existent of imperfect market. When this assumption takes place, there will be no frictional costs and therefore, prices of securities adjustments are based purely on the perfectly competitive market. This notion hold that no excessive capital is needed in order to maximise the value of a portfolio and also that the frictional costs arising from trading and stockbroking, opportunity costs, research time is minimal (Caballero, 1999).

Putting together the assumptions discussed above with other modeling foundations established in the previous chapters, we can perform with parsimony (sufficiency) multi-objective optimisation modeling with MATLAB R2012b and the penalty method algorithms and codes associated to the penalty cost multi-objective optimisation are given in Figure 3.5 below;

First I calculated the optimal vector d which minimizes g(d) with equality constraint and then I used this optimal d to maximize (f(x)-g(d)) with inequality constraint.

```
clc
clear all
load optimsethba.mat    % 2012 data being entered into the model
P = [0.395 0.186 0.18 0.091 0.075 0.074]      % Importance weights of goal constraints
```

$$x_i = \begin{bmatrix} 1695908 \\ 8720001 \\ 1512593 \\ 237515 \\ 1403165 \\ 7747660 \\ 7734865 \\ 1610558 \\ 12916055 \\ 178291 \\ 16736 \\ 1059900 \\ 1391554 \end{bmatrix}, i = 1, \cdots, 13 \qquad y_j = \begin{bmatrix} 1942190 \\ 2173818 \\ 12923159 \\ 11479233 \\ 4032590 \\ 866278 \\ 385138 \\ 509181 \\ 14339 \\ 385138 \\ 14339 \\ 2265490 \\ 0 \\ 209318 \\ 487196 \end{bmatrix}, j = 1, \cdots, 13$$

```
Aeq1=Aeq(:,1:end-1);
%% Second optimization problem
cvx_begin
variable d(13)
maximize(-P*d)
subject to;
Aeq1*d == beq % equality constraint
cvx_end
cvx_optval
```

Figure 3.5: MATLAB Programming Codes
Source: Developed with practical assumptions, for the thesis.

3.13 Methodology Justification and Verification

This section continues to embrace on the balance sheet optimisation objectives with the MATLAB programming codes established for this purpose. The optimisation processes follow the commands (algorithms) illustrated in Section 3.10, Figure 3.3 and Figure 3.4 alongside the above codes in Figure 3.5 (more detail in Appendix B). In dealing with the general constrains with equalities and inequities, the penalty cost optimisation method is the most useful (Lindfield and Penny, 2012; Yang, Cao, Chung and Morris, 2005; p. 346). Written in Yang Cao, Chung and Morris (2005; p. 347) this method is appealing to problems that are fuzzy or loose in nature. It means that the constraints are not strictly zero binding. Even though the thesis is not using the non-zero binding approach, it is however foundational to have this discussion as follows;

Expression 3.27 is established with an objective to minimise function $f(x)$ with object x and that it is subject to both equality ($h(x)$) and inequality ($g(x)$) constraints. The penalty function method consists of two steps as mentioned in Chapter 4. Firstly, a new objective function is constructed (Yang, Cao, Chung and Morris, 2005, p. 347).

$$Min\ l(x) = f(x) + \sum_{m=1}^{M} w_m h_m^2(x) + \sum_{m=1}^{L} v_m \psi(g_m(x)) \tag{3.27}$$

Having constraints structured as the above manner would mean penalizing huge values for the constraint terms in the objective function in Expression 3.27. One might ask if the objective function would be affected if the constraints are satisfied. If the constraints are satisfied, it will not have an effect on the objective function. The following step of the penalty method is to minimise the new function that is without constraint (Yang, Cao, Chung and Morris, 2005, p. 347). Yang, Chao, Chung and Morris (2005) continue writing that however the non-gradient approach has to be taken because of the problems with inequities, termed as $v_m\psi(g_m(x))$ in Expression 3.27 are always almost zero with x staying within the allowable boundary corresponding to $(g_m(x)) \leq 0)$ and therefore, we obtain Expression 3.28 below;

$$where\ v_m = 1, \tag{3.28}$$

$$\psi(g_m(x)) = \begin{cases} 0 & if\ g_m(x) \leq 0\ (constraint\ satisfied) \\ \exp(e_m g_m(x)) & if\ g_m(x) > 0\ (constraint\ violated) \end{cases}$$

$$e_m = 1\ \forall\ m = 1, \dots, n$$

The above can be modified for customisation to suit the operating environment of asset liability management of BIMB. It is the objective for the research to clarify that the above cannot be taken, instead of the expression in Section 3.9.1 because of the characteristics of the constraints which needs to be satisfied. The model above can be used for other problems alike in different operating environment depending on the nature of the industry. It appeals to future researches with optimisation problems having the above constraint characteristics that are with restraining factors to satisfy concurrently both equality and non-equality functions.

In customising the current model for characteristics of the study‟s constraints, we referred to Section 3.9 and the above expressions the multi-objective asset liability management optimisation problem. Thus we present Expression 3.29 as follows for the use of programming in the computational environment in MATLAB R2012b;

$$Objective: \begin{matrix} Max \\ x \end{matrix}\ f(x) = r(1:13) \times x(1:13) \tag{3.29}$$

$$s.t. \qquad Aeq \times x = beq$$

Second function $\begin{matrix} min \\ d \end{matrix}\ g(d) = P(1:6) \times d(1:6)$

$$given\ constraints \quad Aeq \times d = beq$$

3.14 Concluding Remarks

This chapter explains the processes for the development of the asset and liability model to satisfy Research Objective TWO (2) of the thesis; that is to document all the algorithms designed for organisation of assets and liability. It started with introduction to BIMB current financial position, with analysis of its current balance sheet to gather evidences and support for justifications provided to results and findings from Section 5.2. It also developed and documented the algorithm for steps with systematic sequences and processes for the asset liability model development and execution in Section 3.10. The condition for the model‟s practicality while satisfying parsimonious objectives required for a model‟s functionality are considered here. The MATLAB codes (m-codes) are included in Appendix B. The chapter showed m-codes for the model‟s check and validation through the model‟s „check validity‟ function.

The chapter contributes to the body of literature by having two models (Covered in Section 3.10 and Expression 3.27) left milestones to other methodology that is to be considered by further work extensions in future. These milestones are the baseline financial models which have been accepted widely by most researchers. The approaches suggested by the thesis are sufficiently robust to allow for the financial modeling with significant factor contributing variables in the Islamic bank asset liability decision making environment.

More importantly, the current work laid foundational blocks of concepts, models and theories that are relevant to the Islamic bank‟s asset liability portfolio optimisation problem. The discussion started with the well-known concept of portfolio management (consisting only of assets), and then various other appealing models within this area of portfolio management. The chapter continued with consideration given to specific theories and concepts to understand and study the Islamic bank‟s asset liability management problem. It proposes the closest model reflecting the bank"s balance sheet structure and that one should consider the multi-criteria issues when modeling this problem.

The study took a further step to analyse other models available in the market. It was tested and reported by Dupačová (1999) in portfolio optimisation via stochastic programming, errors or misspecifications would evolve as the results of approximation, estimation and incomplete information. The researcher advise further work extensions from this field should consider the Markowitz model that incorporates multi-period features due to fluctuations in cash flows (as funds to be channelled to the asset from the capital side of the balance sheet: liability and equity) caused by differences in the maturity terms and time remaining to maturity to these assets, liabilities and equities, unexpected huge withdrawals, liquidity, uncertainty in the economic environment, volatility in the foreign exchange markets and so on. Banks might need to adjust their buffers to account for all these anomalous cash flows.

Adding to the above methodological contributions, the study proposes a way to rectify challenges in secondary data collection (especially stochastic type of data which requires the participation of bank treasurers who are usually in lack of quality time for such participation) and similar form of data from samples alike in order to delimit potential data collection challenges mentioned earlier. Moreover, separating cash flows and categorising them into different maturity buckets and determining their specific sources and use (allocations) have always been difficult to the researcher who is involved as a third party in the data instrumentation process. To resolve this, the research purposes the assignment of different expected ratios/weights to cash flows gathered at different maturities (See notes to financial statements for market and liquidity risk management). If this approach is taken, the researcher will have assumptions to the ratios/weights assigned. The cash flows are assigned to cater to this purpose.

CHAPTER 4: THE MODEL'S IMPLEMENTATION, RESULTS AND ANALYSIS

4.1 Introduction

This chapter is concerned with the results of the application of the multi-objective asset liability management optimisation (ALM) model. It begins with a subsection to analyse the current balance sheet performance of BIMB before the execution of the model. This subsection consists of the common size and financial ratio analyses. Under financial ratio analysis, several key areas of BIMB"s performance were analysed. They are the quality of assets, the bank"s state of funding as well as the current funding position assessments for BIMB. Next, the section implements the ALM model using the model"s suggested ALM allocation weights to perform gap analyses between the actual and target performances. These results were scrutinised with each slack and surplus identified for every performance target of the ALM model. The slacks and surpluses were obtained from the model"s implementation. Then, the generated weights which are the results of the model"s implementation were used to examine the investment assets" portfolio performance in Section 4.3.4. This chapter concludes with Section 4.5 to provide some remarks gathered during data analyses and an overall summary to Chapter 4.

In summary, all technical aspects involved in the model"s implementation are discussed this chapter. Detailed linkages between actual and proposed ALM allocations were elaborated. A prominent contribution of this research is its attempt to connect and include actual balance sheet situation faced by BIMB using real financial information and then comparisons based on the model"s implementation to examine if this model optimises the ALM performance for the bank.

Other features of the research is its attempt to validate the model using financial ratio analyses with BIMB‟s financial statements starting year 2009 to 2013. Important figures representing the bank‟s ALM strategy are used to establish the components of the ALM optimisation function. To complete the optimisation task, further information regarding the bank‟s regulating and legislative environment were gathered for a holistic model formulation. They are decrees and statutes governing the operations of the Malaysian Islamic banks and financial institutions. Proposed assets and liabilities composition and other comprehensive analysis (See Table 4.9) guiding the understanding of the proposed results are also covered within this section.

4.2 BIMB's Asset Liability Management Current Performance

4.2.1 Balance Sheet Analysis

Comparing the bank‟s financial position on a yearly basis, 2012 and 2013, we can see that the bank‟s total worth measured in the basis of total assets has increased. In order to establish the model‟s components (inputs), data from BIMB‟s financial statements in periods 2009 to 2013 were taken. We therefore assume that the beginning strategic planning period starts with year 2009 and ends in 2013.

The points for decision making for all these financial values are reflected as „end of‟ periods for all years. However, in modeling the multi-objective asset liability optimisation using the penalty method, the study takes 2012 and 2013 data (See Table 3.6) as inputs for the model. The five years data from 2009 to 2013 are used to analyse decision making patterns along with strategic direction analysis with reference from third party independent documents and reports (i.e. Rating Agency Malaysia (RAM) Holdings Berhad) to forecast decisions and policies of the bank. To initiate the model, the study analyses the current balance sheet structure before inputting all data into the model.

All items are viewed based on their theoretical structure governing their sources and uses (i.e. fund mobilisation). Keep in mind that the five years data were obtained only to aid analysis and decision making pattern mapping. It is not exhaustively subjected to financial performance findings from ratio analysis. Formulas documented by RAM Holdings (Wong and Lee, 2014) were used with verbal consent and permission prior to the adoption. Calculations were detailed out for year 2009 to 2013 in Table 4.5.

Table 4.1 is presented in the balance sheet Expression format in which total summation of all x variables should equal to the summation of all y variables. Analysing the composition of the balance sheet based on vertical analysis, we can see that resources allocation (the bank‟s resource utilisation based on budget allocation) for each class of asset. The analysis takes total assets as the base to total amount of resources available to the bank as at the end of year 2012 and 2013. The analysis is provided in Table 4.2 below. The bank‟s balance sheet can be categorised into two main groups based on the item‟s maturity (liquidity). When we perform the vertical common size analysis for two asset classes; (1) securities portfolio and (2) Financing, advances and Other using (1) total value of the securities portfolio and (2) total size of Financing, advances and others, using vertical analysis. The current asset allocation tested using vertical analysis is presented in Table 4.3 and Table 4.4. The results of this analysis are given in the following part of this section.

Table 4.1: BIMB's Actual Balance Sheet Data for 2012 (in RM '000)

Variable designation	Values	Asset Category	Variable designation	Values	Liability Category
X_1	1695908	Cash, and other short term near cash liquid assets	**Demand deposits: *Mudaraba* funds**		
Financing, advances and others			Y_1	1942190	Savings deposits
X_2	8720001	*Bai''bithaman Ajil*	Y_2	2173818	Specific Investment Account
X_3	1512593	*Bai' al-'inah*	Y_3	12923159	General Investment Account
X_4	237515	*Ijara*	**Demand deposits: Non-*Mudaraba* funds**		
			Y_4	11479233	Demand deposit from customers
X_5	1403165	*Murabahah*	Y_5	4032590	Negotiable Islamic Debt Certificates, *Ziyad* and others
X_6	7727660	*Tawarruq*	**Other types of deposits**		
			Y_6	866278	Deposits and placements from other financial institutions[44]
X_7	7734865	Other modes of financing	**Other Liabilities**		
Investment securities portfolio			Y_7	385138	Bills and Acceptances Payable
X_8	1610558	Held-for-trading securities	Y_8	509181	Other liabilities, accrued zakat and tax liabilities
X_9	12916055	Available-for-sale securities	Y_9	14339	Derivative financial liabilities
X_{10}	178291	Held-for-trading securities	**Equity Category**		
X_{11}	16736	Derivative financial assets	Y_{10}	2265490	Paid up capital
X_{12}	1059900	Statutory reserve	Y_{11}	-	Share premium
X_{13}	1391554	Non-current assets	Y_{12}	209318	Retained earnings
			Y_{13}	487196	Other reserves

[44] These funds are usually saved in the form of *mudaraba* agreement between the bank and other financial institutions (Usmani, 1999).

Table 4.2: Horizontal Analysis: BIMB's 2012 and 2013 Asset Data

Variables	Current allocation			
	2013		2012	
	in RM mil	in Ratio	in RM mil	In Ratio
X1	3730911	0.0871	1695908	0.0453
X2	9162344	0.2140	8720001	0.2330
X3	1282498	0.0300	1512593	0.0404
X4	250897	0.0059	237515	0.0063
X5	841338	0.0197	1403165	0.0375
X6	**12477947**	**0.2915**	**7727660**	**0.2065**
X7	227496	0.0053	7734865	0.2067
X8	1216895	0.0284	1610558	0.0430
X9	**12416921**	**0.2900**	**12916055**	**0.3451**
X10	63327	0.0015	178291	0.0048
X11	**29118**	**0.0007**	**16736**	**0.0004**
X12	1297100	0.0303	1059900	0.0283
X13	274755	0.0064	1391554	0.0372
Total Assets	**42811371**	1.00	**47146591**	1.00

Table 4.2 shows static data obtained from the bank‟s balance sheets and each figure represents the value carried by the decision variables x_a, y_b with $a, b = \{1, \cdots, 13\}$ for years 2012 and 2013. These values will be entered into the model for a set of feasible solutions. These models suggested solutions will be explained in detail in Section 4.5 of this Chapter. Total asset value of the securities portfolio in year 2013 and 2012 are 36,221,196, and 32,602,145 respectively. Whilst the Financing Advances and Other Portfolios carry a total value of 24,242,520 and 27,355,799 for years 2013 and 2012 respectively. One may refer to the denotations of each x variables from Table 4.1. We can also observe that most allocations are assigned to Securities portfolio consisting of "Available-for-sale" investments. The second top most budget allocation was given to *Tawarruq* based financing. Align with the bank‟s current strategy, attention shift was

given to *Tawarruq* based products as opposed to *Bai'al Inah* since the later product is considered by the Islamic scholars as a way that will open to interest-like business more emphasis on *Tawarruq* product was.

Table 4.3: Securities Portfolio Asset Allocation Analysis (Current)

Variables	Current allocation			
	2013		2012	
	in RM mil	in Ratio	in RM mil	In Ratio
X8	12,416,921	0.3438	12,916,055	0.3962
X9	63,327	0.0018	178,291	0.0055
X10	23,221,196	0.6411	19,507,799	0.5984
Total	36,221,196	1.0000	32,602,145	1.0000

Table 4.4: Portfolio of Financing, Advances and Others (Current)

Variables	Current allocation			
	2013		2012	
	in RM mil	in Ratio	in RM mil	In Ratio
X2	9,162,344	0.37795	8,720,001	0.3188
X3	1,282,498	0.5290	1,512,593	0.0553
X4	250,897	0.0104	237,515	0.0087
X5	841,338	0.0347	1,403,165	0.0153
X6	12,477,947	0.5147	7,747,660	0.2832
X7	227,496	0.0094	7,734,865	0.2828
Total	24,242,520	1.0000	27,355,799	1.0000

The following section of this chapter provides analysis on the bank‟s financial ratio as part of the management‟s historical assets liabilities and management strategy evaluation to deal with relevant strategic policy constraints used to model the asset liability optimisation. Some of these policies are covered in Chapter 3.

Repetitive discussions will appear in this chapter to provide emphasis on the asset liability management before formulating the mathematics to encapsulate the management‟s practices will not be covered in much detail under this chapter to avoid recurring discussions. Likewise, it should also be noted that discussions for liabilities and sources of funding is out of the scope of this thesis. Interested readers may refer to resort to readings that are related to fields Islamic financial institutions funding and capital structure like Al-Deehani, Karim, and Murinde (1999) on “The capital structure of Islamic banks under the contractual obligation of profit sharing”, Archer, and Karim, (2006) on “On capital structure, risk sharing and capital adequacy in Islamic banks” and so on.

4.2.2 Ratio Analysis

This section analyse ratio calculations performed using BIMB‟s financial data from year 2009 to 2013. The objective of this section is to identify the pattern and strategy imposed on assets and liabilities management. Results from the computations are tabulated in Table 4.3. There are altogether three categories of financial ratios, analysed to grasp the notion on how asset and liability are being managed by BIMB. The category of ratio in Table 4.5 presents the bank‟s assets quality. There are five representing ratios with the first one as gross impaired financing ratio, then net newly classified impaired financing ratio, financing credit cost ratio, impairment charge ratio and gross impaired financing coverage ratio.

The second type of ratio examines the liquidity and funding performance and condition of the bank. This ration is represented by liquid asset ratio, interbank deposits to total profit bearing funds, customer deposits to total (Current and Savings Accounts) deposits to total deposits and the financing to deposits ratio. The last category of ratio describes the bank‟s current state of capitalization. The ratio covers the internal rate of capital generation, tier-1 capital ratio and total capital ratio. The assets quality ratio assesses the management‟s quality in utilising capital by the providers of funds. Whereas, liquidity analysis examines the liquidity position of the bank given its ability to fulfil debt obligation when it becomes due. The funding ratio on the other hand analyses the bank‟s capital structure, its sources of funds and the associated portion for each category of fund provision. The third ratio category looks at the bank‟s capitalization, and most importantly, the ratio of total quality capital available to fund operations.

The following sections suggest the results from the outcome of the ratio analysis. All analysis is covered briefly whereas the details to the descriptions and implications to analysis for each ratio obtained will be discussed in Chapters 4 and 5. Since the objective of this section provides insights only to managerial assets and liability management, only patterns and forecasted directions to the growth of the items analysed will be considered.

4.2.2.1 Quality of Assets

BIMB‟s gross impaired financing experienced huge improvements since year 2009, with a ratio of 12.7% to 1.36% in 2013. This is characterized by a significant decline of 89.29%. Referring to reports by the third party‟s rating (RAM, 2013); the bank improved its collection strategy on personal financings through direct monthly staff salary deductions made by employers to service outstanding loans. As we can see from the calculations, gross impaired financing coverage ratio showed increased robust coverage from 77.12 times in 2009 to 163.7 times in 2013.

Although the bank‟s performance in financing management, it faces maturity problem that is expected to dampen future growth. Statistics indicate that with the improved quantity of personal financing, the bank should experience higher income margin. Tenure allowed on personal financing however, has reduced the bank‟s liquidity position given that most provisions focuses on maturity of 10 to 15 years. This is inconsistent with the central bank‟s objective to ail credit risk problems by limiting tenure to 10 years (RAM, 2013, p. 11). The liquidity risk management features by incorporating stages of expected cash flows is not within the scope of the current study because such model (known as the multi-stage stochastic model) can only be developed if data pertaining to the probabilities of cash flow at each maturity bucket should be available (Mulvey and Shetty, 2004; Dantzig and Infranger, 1993).

The bank‟s assets quality for business financings progressed satisfactorily from the perspective of the lowered default rate of 2.9% in 2009 to 2.7% in year 2013. The main contribution to this slight decline could be the cause of the central bank‟s "single-customer exposure" policy[45].

The bank is also seen as a conservative investor. Its securities investment portfolio is mainly concentrated in the low risk-high rating investments. 34% of its portfolio is allocated to asset-based securities. The bank chooses to invest in mostly government-guaranteed investments; investments that possess the quasi-government structure, AAA- and AA rated investments, hence, forming a portfolio of 99%

[45] Bank Negara Malaysia tabulated the "Single Counterparty Exposure Limit" guideline in February 2013 to ensure that exposures to a single counterparty or a group of connected party to the same financial transaction are within a sensible perimeter at all times (para. 1.2). The guideline was the result of the updated Bank Negara requirements enacted in the Financial Services Act (2013) (Section 50). Factors leading to counter party concentration risk are also defined in para. 1.1 of the Guideline.

investments with high credit profile. The bank holds a policy that invests only in securities with at least AA rating in order to reduce default risk. Analysing this approach from the finance and investment perspectives, the contra outcome as a result of lower risks investment is the greater possibility to lower investment returns. Moreover, the bank keeps a bigger than average portion of investments with shorter maturity to enhance liquidity position. We can see that the bank faces problem of overly liquid balance sheet. Coupled with these problems, current liquidity issues due to limited Islamic financial products within the Islamic Money Market escalated the bank‟s high liquidity problem (Hesse, Jobst and Solé, 2008). The Malaysian third party rating agency, Rating Agency Malaysia (RAM) Holdings stated that the bank is one of its rated highly liquid banks compared to its group of other commercial banks. BIMB carries a liquid assets ratio of 47.13 times in year 2013 as opposed to 2012 of 67.38 times.

4.2.2.2 The State of Funding

As for funding concentration analysis, the bank showed an extreme concentration risk given that most sources of funding deposits were the contribution of *Lembaga Tabung Haji* (RAM, 2013), its major shareholder. The financing-to-deposit ratio rose to 61.40% which is below the industry‟s average. Looking at this indicator, the bank is portrayed as a conservative investor. In order to boost its financing to funding market share, the bank plans to lift the ratio to 75% by the end 2015. The overall total financing of the bank has risen, and this rise gave the heap to its pre-tax in 2012. As a consequence, the return on total assets ratio hyped. The bank has a strong CASA (Current and Savings Accounts) funding composition and these sources of funding are considered low cost and almost riskless (Handa, 2002; p. 121) to the bank.

In spite of this, the bank‵s profitability stifled due to its high cost-to-income ratio. The ratio registered for 2013 was 55.1% presenting increased expenses incurred for the bank‵s expansionary moves. Furthermore, the bank spent largely for its new premises at the end of 2013 (p. 9).

The second factor constituting to increased cost-to-income ratio was less than industry average income from non-financing business. This includes investment income, fees generated from the debit and credit card facilities, *Bancatakaful*[46], or products based on the *al-Ujr* principle of *Shari'ah*. The bank is financed primarily by fairly less risk and low cost deposits from current and savings accounts. Whilst, increased financing portfolio boost the bank‵s earnings margin. This has led to an overall increase in the 2012‵s pre-tax earnings. In general, the bank‵s funding structure is made up predominantly of its customers and deposit taking business, followed by institutions, its shareholder and internal reserves. Compared to year 2012, there has been a slight shift in funding structure, in that the bank experienced small surge in deposits from institutions and other banks.

Adding to the above findings, further balance sheet analysis finds that BIMB‵s personal financing since January 2012, the Bank‵s personal financing facilities have been offered as floating-rate products. As a result, floating-rate facilities ballooned to 55.1% of BIMB‵s financing portfolio as at end-June 2013, from only 26.1% as at end December 2011; this is close to the Bank‵s targeted 60%. Meanwhile, we note that the Bank‵s personal financing products have been shifting away from the *Inah* concept, and are now offered through the generally more accepted *Tawarruq* concept (RAM, 2013; p.4). All annualized costs for variables y_1 to y_6 are derived from the data obtained from the bank‵s deposit rates website given in Table 3.7.

[46] *Bancatakaful* is a product that enables protection to valuable home and personal belongings. It is the outcome of cooperation between the bank and Syarikat and your home contents and precious personal belongings according to your needs.

4.2.2.3 Capitalisation

Internal capital efficiency deteriorated since year 2010 from a ratio of 12.73 to 9.03. Tier-1 capital ratio suggests that the bank has fairly downgraded risk coverage ability with its quality capital. Backed also by the findings in total capital ratio, the indication provides that the bank‟s risk exposure management has somewhat declined. The types of risks under the 8% minimum capital requirement by Basel II are market risk, liquidity risk and operational risk. In spite of this, the bank‟s pre-tax profit increased slightly from year 2012 to 2013 from RM595 million to RM675 million. The bank‟s main capital originates from its depositing business, dominated by its customers.

Table 4.5: Financial Ratios Analysis for BIMB for years 2009 to 2013

Ratios	Formula	2009	2010	2011	2012	2013
Asset Quality (%) • Gross impaired financing ratio	$\frac{Total\ Impaired\ Financing}{Gross\ Financing\ \&\ Advances}$	12.70	4.50	2.61	1.55	1.36
• Net Newly Classified Impaired Financing Ratio	$\frac{Net\ Newly\ Classified\ Impaired\ Financing}{\text{Average Gross Financing \& Advances}}$	(0.82)	(2.08)	0.10	0.47	0.37
• Financing Credit Cost Ratio	$\frac{Net\ Impairment\ Charges\ on\ Financing}{\text{Average Gross Financing \& Advances}}$	1.16	1.22	0.16	0.38	0.02
• Impairment Charge Ratio	$\frac{(Net\ Impairment\ Charges\ on\ Financing\ +\ Net\ Impairment\ Charges\ on\ Financial\ Investments)}{(Average\ Gross\ Financing\ \ Advances\ +\ Average\ Total\ Financial\ Investments)}$	0.76	0.65	0.13	0.21	0.01
• Gross Impaired Financing Coverage Ratio	$\frac{Total\ Provisions}{Gross\ Impaired\ Financing}$	77.12	77.17	106.23	142.63	163.77
Liquidity & Funding (%) • Liquid Asset Ratio	$\frac{Liquid\ Assets}{(Customer\ Deposits\ +\ Short-Term\ Funds)}$	67.38	65.30	56.90	47.93	47.13

• Interbank Deposits to Total Profit Bearing Funds	$\frac{Interbank\ Deposits}{Profit\ Bearing\ Funds}$	0.03	1.38	1.33	2.55	3.63
• Customer Deposits to Total Profit Bearing Funds	$\frac{Customer\ Deposits}{Profit\ Bearing\ Funds}$	98.47	98.02	97.77	96.31	95.79
• CASA Deposits to Total Deposits	$\frac{(\text{Current Account} + \text{Savings Account Deposits})}{\text{Customer Deposits}}$	35.95	39.69	43.42	11.23	36.53
• Financing to Deposits Ratio	$\frac{\text{Net Financing \& Advances}}{\text{Customer Deposits}}$	38.33	44.14	50.08	59.93	61.36

CAPITALISATION (%)		**2009**	**2010**	**2011**	**2012**	**2013**
• Internal Rate of Capital Generation	$\frac{Net\ profit(or\ loss) - \ Dividends}{Average\ Total\ Equity}$	11.36	12.73	9.36	9.50	9.03
• Tier-1 Capital Ratio	$\frac{\text{Tier} - 1 \text{ Capital}}{\text{Total Risk} - \text{Weighted Assets}}$	12.25	15.71	15.55	12.94	12.29
• Total Capital Ratio	$\frac{\text{Total Capital}}{\text{Total Risk} - \text{Weighted Assets}}$	18.87	16.92	16.72	13.99	13.37

Table 4.6: BIMB's Current Balance Sheet Performance with 2012 and 2013 Input Data

Target Descriptions	Variable	Results of The Deviations for Target Constraints 2012 and 2013 2012 Values (RM in Mil)	d_i^+ $i = 1,..,5$	d_i^- $i = 1,..,5$	2013 Values (RM in Mil)	d_i^+ $i = 1,..,5$	d_i^- $i = 1,..,5$
Performance Revenue	P1	N/A	N/A	N/A	297,570.55	1	0
Capital Adequacy	P2	2,204,379.75	1	0	2,717,379.11	1	0
Liquidity	P3	1,370,398.1	1	0	3,362,046.10	1	0
Total Assets Growth	P4	N/A	N/A	N/A	46,181,764.78	0	1
Total Deposit Facility	P5	13,656,025.20	1	0	5,285,671.15	1	0

Note: d_i^+, d_i^- denotes over- and under-achievement using the bank‟s actual balance sheet figures. When the value 1 is applied to d_i^+ in P1, it shows that for target P1, the bank experience over-achievement. Whereas, if the value 0 is applied to d_i^-, the bank under-performed for target P1. Results for performance revenue (P1) and total assets growth (P4) are not applicable since plans for revenue and assets growth expected for year 2012 takes some time to be realised and that its effect could be observed in 2013.

Table 4.7: Targets Achievement Using Proposed Assets and Liabilities Allocation for 2012 and 2013

Target Descriptions	Variable	Results of The Deviations for Target Constraints 2012 and 2013 2012 Values (RM in Mil)	d_i^+ $i = 1,..,5$	d_i^- $i = 1,..,5$	2013 Values (RM in Mil)	d_i^+ $i = 1,..,5$	d_i^- $i = 1,..,5$
Performance Revenue	P1	N/A	N/A	N/A	486,760.48	1	0
Capital Adequacy	P2	10,699,290.00	1	0	7,588,928.69	1	0
Liquidity	P3	520,080.41	1	0	224,129.79	1	0
Total Assets Growth	P4	N/A	N/A	N/A	224,536.35	0	1
Total Deposit Facility	P5	17,637,321.14	0	1	5,849,821.39	0	1

Note: Projections for 2013 „Performance Revenue‟ and „Total Assets Growth‟ are done using proposed assets and liabilities composition for year 2012. Therefore, results for these two targets are not applicable to year 2012.

Table 4.8: Deviations in Targets Achievement: Comparison Between Actual and Expected Performance for 2012 and 2013

Target Descriptions	Variable	2012 Values (RM in Mil)			2013 Values (RM in Mil)		
		Expected performance	Actual performance	Difference	Expected performance	Actual performance	Difference
Performance Revenue	P1	N/A	N/A	N/A	806,403.19	292,040.05	514,363.13
Capital Adequacy	P2	793234.52	788,715.55	4518.52	1,941,865.04	251,629.42	1,690,235.62
Liquidity	P3	1133748.21	1,127,851.18	5897.03	361,976.48	1,371,915.12	1,009,938.64
Total Assets Growth	P4	N/A	N/A	N/A	5,804,561.00	10,401,712.00	4,597,151.00
Total Deposit Facility	P5	93,161,809.70	27,719,428.94	65,442,380.76	10,981,041.93	63,234,976.25	52,253,934.32

Note: Table 4.8 consists of results showing BIMB‟s expected and actual performances for targets P1 to P5 described above. These performances are obtained through calculations using constraint formulas developed in Chapter 5 of and were replicated below for convenience. Inputs for the formulas were done with simulated data (to get results for expected performances) and actual balance sheet data (for BIMB‟s current performances).

4.3 Analyses and Results: Portfolio Performance and Gap Analyses – Slacks and Surpluses

Further discussions to results obtained in Table 4.6, using simulated proportions of assets and liabilities by the asset and liability model within the MATLAB R2009b environment are available throughout these sub-sections. Table 4.5 and Table 4.6 consist of results that are arranged in the following format; (1) deviation values for years 2012 and 2013 (these deviations represents gaps between the expected and actual performances using BIMB‟s simulated and actual balance sheets for the asset and liability model and these values are given in millions of Ringgit Malaysia); and (2) dummy values of 1 and 0 to denote manifestations of the under- or over-achievements for targets P1 to P5. For example, dummy variable of 1 for d_1^+ for P1 represents over-achievement for target P1 (Performance Revenue). Accompanying explanations to each targets‟ deviation will be elaborated below.

4.3.1 Forecasted Results, Slacks and Surpluses

Achievements using proposed asset and liability allocation for targets 1 to 5 denoted by P1 to P5 are shown in Table 4.6. As mentioned in Chapter 3 and Chapter 4, these results could imply positive or negative outcomes for under- or over-achievement of the asset and liability management targets, depending on the severity of such deviation. The deviation‟s impact is assigned using parameters of importance acquired from the minimisation search process in Chapter 3. This method prevents over- and under-valuation for targets that are conflicting with other targets assessed.

Using the assets and liability allocation that is suggested by the model, the bank will have experience over-achievement for its revenue performance target by RM 486,760.48 million which is RM 189,189.93 million above its actual performance by RM 297,570.55 million. The above figures were obtained using suggested assets and liabilities that were substituted into mathematic formulation (Section 3.9, algorithms in Figure 3.3 and Figure 3.4). For convenience, the replica for Expression 4.1 is presented below;

$$\left[0.0274x_1 + 0.0633(\sum_{i=4}^{7} x_i + x_2 + x_{10}) + 0.075x_3 + 0.0346x_8 + 0.04x_9\right] - [0.05y_1 + 0.0495y_2 + 0.0367y_3 + 0.0735y_4 + 0.0325y_5 + 0.0325y_6] + d_1^- - d_1^+ = 478428 \quad (4.1)$$

The excess overachievement for target P1 using simulated balance sheet with the asset and liability model recommends that the bank would continue to achieve this good result if it abides with the suggested allocation. The performance revenue result is only applicable to year 2013 because projections for year 2013 can only be done with 2012 data. Besides, in model formatting, we need to consider the effects of all legal and operating perspectives on the asset and liability management policies and implementation.

All these factors should be considered together and not in isolation while completing the steps outlined in the algorithm on Figure 3.4, the processes within the asset and liability optimisation model. Target P2 shows capital adequacy performance. Here, using the allocations simulated by the asset and liability model, the bank would experience over-achievements for both years. The actual and expected performance gap for capital adequacy target (P2) shown in Table 4.8 for 2012 is RM 8,494,910.25 million. This means that with the implementation of the proposed allocations, the bank will exceed the current over-performed capital adequacy provision in 2012. In 2013, the bank would exceed the current over-performance in realising its capital adequacy by

RM4,871,549.58 million if the allocations were implemented. Reported in Table 4.8, the bank‟s expected performance and actual performance for this target in year 2012 are RM10,699,290 million and RM2,204,379.75 million respectively, whereas, these performances for year 2013 were reported to be RM7,488,928.69 million and RM2,717,379.11 million. Recalling Chapter 3, Expression 4.2 is presented below for convenience.

$$\sum_{j=10}^{13} y_j - 0.08\left[0 \times (x_1 + x_8 + x_{12}) + 0.2\left(\sum_{i=2}^{7} x_i + x_9\right) + 0.125(x_{10} + x_{11}) + x_{13}\right] + d_2^- - d_2^+ = 0 \tag{4.2}$$

Target P3 represents the bank‟s achievement for its liquidity management. Working on the current allocation, the bank is experiencing an over-liquid position given an over achievement indicated by the dummy value for d_2^+ in Table 4.6. The over-liquid position can be lowered if the bank follows the suggested assets and liabilities allocation using the model, and the new over-achievement for liquidity provision will drop to RM 520,080.41 million, that is, a difference of RM850,317.69 million, for year 2012. Whereas, in year 2013, the bank showed an over-achievement for its liquidity position by RM 3,362,046.10 million and a lowered value of RM 224,129.79 million is expected if the bank implements the suggested allocation. This difference created an over-achievement gap of RM 3,137,916.31 million. In general, the Islamic financial system faces liquidity problem (RAM, 2014) arising due to the lack of money market instruments available in the Islamic Interbank Money Market (IIMM). Calculation for deviations in target P3 can be done by substituting the simulated asset and liability allocation into Expression 4.3 (represented below) in Chapter 3.

$$x_1 - 0.01\sum_{j=1}^{5} y_j + d_3^- - d_3^+ = 0 \qquad (4.3)$$

The next target, total assets growth is denoted by P4. Table 4.5 showed under-achievement for this target hen the bank‟s actual balance sheet data is substituted into Expression 3.5 below. The methods to calculate the target‟s over- or under-achievement are repeated to obtain information about the bank‟s achievement for target P4. Comparing these outcomes (summarised in Table 4.8), gap obtained from the difference between the actual (RM46,181,764.78 million) and expected (RM 224,536.35 million) performances for target P4 (total assets growth), the bank faced greater under-achievement of RM3,137,916.31 million. The suggested allocation tells that the bank would not able to attain the results of intended performance even though with the suggested allocation, the bank could minimise such under-achievement.

This might possibly signal that the bank is engaging in organic expansionary moves rather than mechanistic expansionary, that is characterized by aggressive acquisition and takeover actions. In this type of slow and conservative growth, total assets will grow in a steady and gradual momentum, characteristics that are different than the aggressive, rapid and mechanistic growth. Similarly, the total assets growth target is performed using planned percentage of growth expected in year 2012. Therefore, calculations for this growth can be done using actual and suggested assets allocation from year 2013. For this reason, the total assets growth is not applied to year 2012. Calculations can be done by substituting all simulated and actual financial data components into Expression 4.4, represented below;

$$\sum_{i=1}^{13} x_i + d_4^- - d_4^+ = 47146591 \qquad (4.4)$$

Finally, target P5 which denotes the total deposit facility performance represents the bank‟s level of aggression in expanding deposit facilities available to support all funds needs in addition to maintaining the level of funds available for attractive investments. Assets and liabilities obtained from simulation approach and actual balance sheet data collection was substituted into Expression 4.5 (shown below, as a replica of the Expression in Section 3.9). From the calculations, we obtained both expected and the bank‟s actual performance for 2012 and 2013 as shown in Table 4.7, Table 4.8 and Table 4.9. Important findings shown in these tables were summarised in Table 4.9. The gap of RM 3,981,295.94 million and RM564,150.24 million represents that the bank will experience over-achievements for its intention to expand deposit facility above its current performance if it follows the recommended set of assets and liabilities allocation. Expression 4.5 below was taken to measure the bank‟s achievement (over- or under-) for target P5, the total deposit facility performance.

$$\sum_{i=2}^{10} x_i - 0.85 \sum_{j=1}^{6} y_j + d_5^- - d_5^+ = 0 \qquad (4.5)$$

4.3.2 Proposed Assets and Liabilities Composition

The proposed and actual assets and liabilities compositions can be made meaningful if we perform the common size analysis[47] with the total assets as the base year since results obtained for the assets and liabilities matrices are only two years (i.e. 2012 and 2013). Table 4.9 shows comparisons of the two years‟ proposed and actual

[47]A common size analysis presents the numeric values of all items within the balance sheet as a percentage relative to the total values of the corresponding entries. For example, the common size percentages of assets are compared to the total assets whereas, the common size of the total liabilities are compared to the total liabilities and stockholder equity (Garrison, 2003).

allocations. These were also the figures used to generate the over- or under-achievement gaps discussed in Section 4.3 and 4.4. From the common size analysis, we summarise that the proposed allocations and the current allocations deviate in slight significance. The assets allocations suggested for BIMB‟s assets for year 2013, following the sequence of asset x_1 till x_{13} are summarised as 0.016, 0.1, 0.044, 0.016, 0.666, 0.005, 0.007, 0.02, 0.039, 0.028, 0.017, 0.034, and 0.007. Whereas, proposed allocations for liabilities starting with y_1 *to* y_{13} can be summarised as 0.601, 0.066, 0.011, 0.051, 0.06, 0.002, 0.011, 0.139,0, 0.019, 0, 0, and 0.041. Assets allocations for year 2012, following the earlier sequence are 0.039, 0.222, 0.141, 0.106, 0.15, 0.009, 0.016, 0.053, 0.067, 0, 0.064, 0.104, and 0.029. Proposed allocations for 2012 liabilities are 0.4, 0.001, 0.007, 0.394, 0.024, 0.014, 0.006, 0.096, 0.007, 0.012, 0, 0.01, and 0.029.

The financial ratio analysis above suggests enhanced liquidity for BIMB with indicated by an increase in the allocation for asset x_1 which is more than half the times of its initial holding. This liquidity performance is proposed based on the liquidity constraints and other multi-objective functions established for the model. The ALM model proposed a reduction for allocation to x_3, the *Ijara* based financing. Since this allocation is suggested by the model, it can be revised to meet BIMB‟s need objective to provide non-interest lease through *Ijara* as an alternative to conventional based lease to cater to the *Shari"ah* concerned investors.

We can also compare these allocations with the actual allocations using the common size analysis for the two years for other significant balance sheet items with larger than expected variances. Table 4.8 also provides this comparison with the proposed and actual allocations presented next to one another for a clearer view on the deviations for the two results. As we can see, the deviations are not significant. Taking a closer look into the suggested and actual allocations for asset x_1 given for year 2013, the allocation compared to the size of the total proposed value of assets when all objectives are satisfied, the bank should allocate an amount which is 1.6% out of its total assets to cash and other short term near cash liquid assets compared to 8.6%, which is the actual balance sheet composition in year 2013.

The proposed total financing, advances and others were estimated to increase from year 2012 to 2013. Satisfying the multiple objectives of the bank‟s ALM, the bank should increase its financing, advances and others portfolio from 0.644 to 0.835 (taken by adding all variables x_2 to x_7). A detailed result for financing mix and compositions is included in Section 4.3.3. This group of assets consists of financing, advances, loans and non-interest asset-backed loans. Next, we can see the common size ratios calculated for both equities and liabilities to total equity and liability capital. We can see that in satisfying the bank‟s multiple asset liability management objectives, the proposed composition for *mudaraba* type of saving increased from year 2012 to 2013, that is, 0.408 to 0.678. This suggested an increase of approximately 60%. These values are higher than the current *mudaraba* savings compositions (total value of variables value of variables y_1, y_2 and y_3 experienced by the bank (See Table 4.8). In line with the structural changes in efforts to strike a balance between fixed income structure and the need for more resilient capital base in promoting budgetary management for lucrative projects and financings in recent years have shifted Islamic financial institutions‟ preferences towards *murabahah*, *wakalah* and *mudaraba*. This move is one of the key drivers to the significant increase in the composition allocated to *mudaraba* type financing compared to other types of *Shari'ah* compliant products (International Islamic Financial Market Sixth *Sukuk* Report, 2017, October 29).

In additional to the shift in the Islamic financial product preferences, preferences towards the types of deposit capital offered by BIMB in order to suit religious and economic environmental shifts have also witnessed significant level of change. Looking at the proposed mix for Specific and General Investment Accounts, the ALM model proposed an increased allocation for General than Specific Investment Accounts form year 2012 to 2013. These allocation suggestions were based solely on the execution of the model in the support for more focus to the General Pool of Investment Account so that this fund can be used ethically without specific conditions placed by the accountholders.

However, according to the Islamic Financial Services Act (2013), Islamic banks in Malaysia are no longer encouraged to use *mudaraba* investment contract for the deposit products offered. These banks are now required by this act to categorise carefully the segregation of funds into specific uses such as the deposing or investment purposes (Islamic Financial Services Act, 2013). The General and Special Investment Accounts are acknowledged by the Banks for International Settlement (BIS) as investments qualified to form part of the core capital components in order to absorb unanticipated or contemporary business risks. This allowance is also contained in the AAOIFI standards, a reference instead of a concrete guidance viewed by Islamic banks in Malaysia. The main source of reference among these banks are still the Islamic Financial Services Act (2013) enacted by the central bank of Malaysia.

The proposed non-*mudaraba* deposits composition (results obtained by totalling variables y_4 and y_5) dropped from ratio 0.408 in year 2012 to 0.111 in year 2013. Whereas in actual, there is only slight drop experience by the bank (shown in Table 4.8) that is, from 0.418 to 0.328. The summation of the total equity (y_{10} to y_{13}) proposed by the asset liability model in Table 4.8 suggested an increased by 17% as compared to its actual decreased of 2.5%, that is calculated using the balance sheet data for both years.

In this section, all discussions pertaining to justifications for the proposed and actual allocation (computed using the common size analysis will be discussed in Chapter 4. A brief look into the bank‟s liquidity management, should the bank followed the suggested allocation it will have an improved total current assets ratio from year 2012 to year 2013, from 0.956 times to 1.141 times. Comparing with the actual ratios, the respective ratios were 0.937 and 2.951 times. With the proposed assets allocation, the current ratios do not deviate much from one year to another. Although the actual current ratio suggests that the bank has higher performance for year 2013, RAM (2014) reported that the bank is facing over-liquidity problem. In line with the above discussions, the increase is largely attributable to the significant increase in asset x_1 which fulfils BIMB‟s objective in promoting and attracting more deposit placements with new products like *Al-Awfar, Wadiah* Savings Account-i, and *Wafiyah* Investment Account. These are among the new Islamic financial innovations by BIMB. In addition to this justification, the Ratings Agency Malaysia reported that in year 2014 (since this analysis is based on data generated using 2012 and 2013 BIMB‟s financial information), BIMB is considered as one of the Islamic banks with conservative funding and liquidity profile (RAM, 2014, p. 2). It is at the same time the cause of less liquid Islamic Money Market. These banks are prohibited to access conventional money market to manage liquidity problems. These are the causes to BIMB‟s excessive liquidity position and thus are counterproductive to that bank (Abdul-Rahman, 1999). Excess liquidity problems lead to inefficient funds mobilisation in an economy. This situation makes fund transfers from the surplus to deficit units of the economy inefficient due to the lack of liquid financial instruments in the Islamic money market.

All results of the actual and proposed allocations based on the execution of the ALM model are presented in Table 4.9. These results are summarised statistically with bar charts to highlight significant differences in Figure 4.1 to Figure 4.4. Comments on suggested adjustments to increase or decrease the proposed allocations are included with justifications to accompany these adjustments.

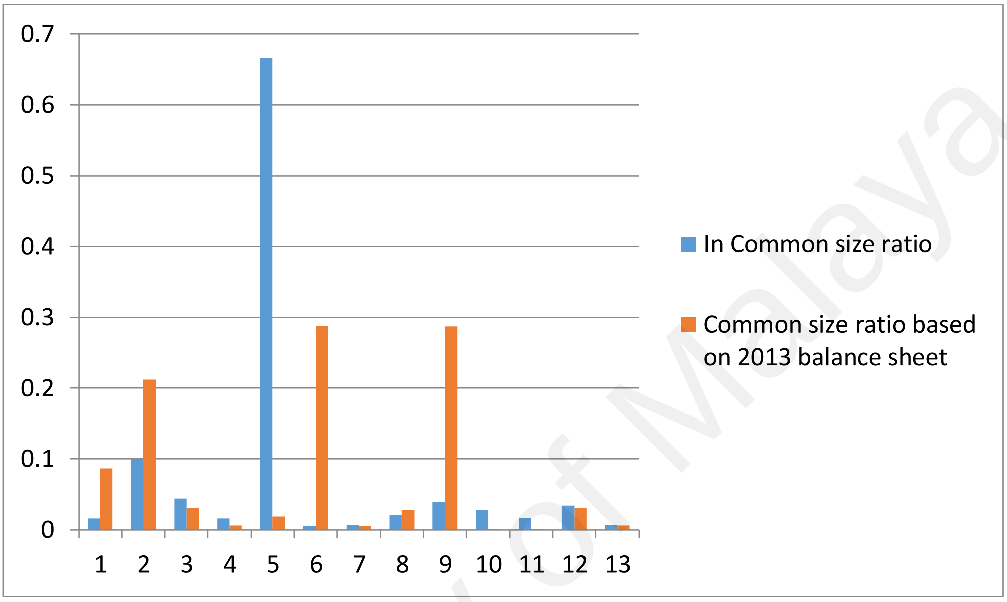


Figure 4.1: 2013, Proposed Assets Composition

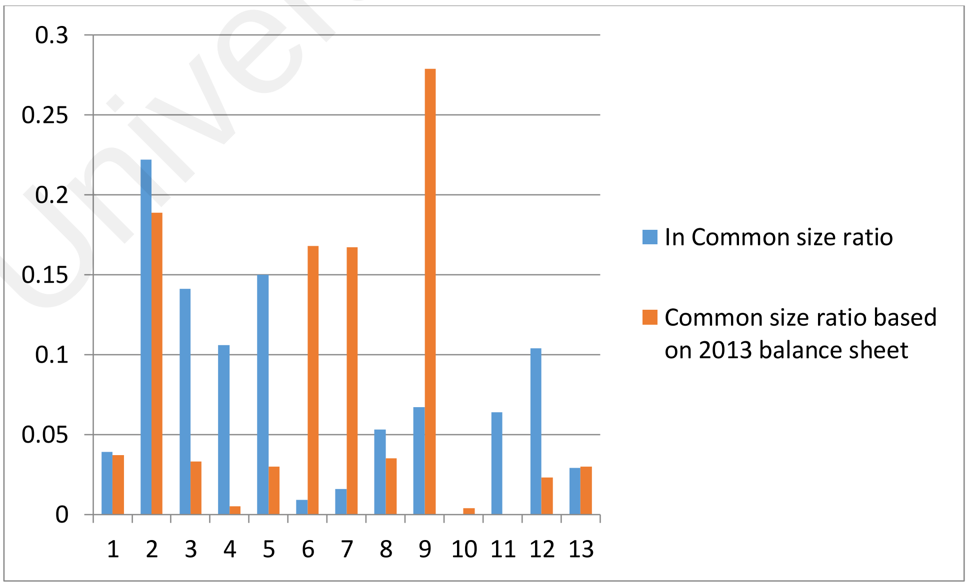


Figure 4.2: 2012, Proposed Assets Composition

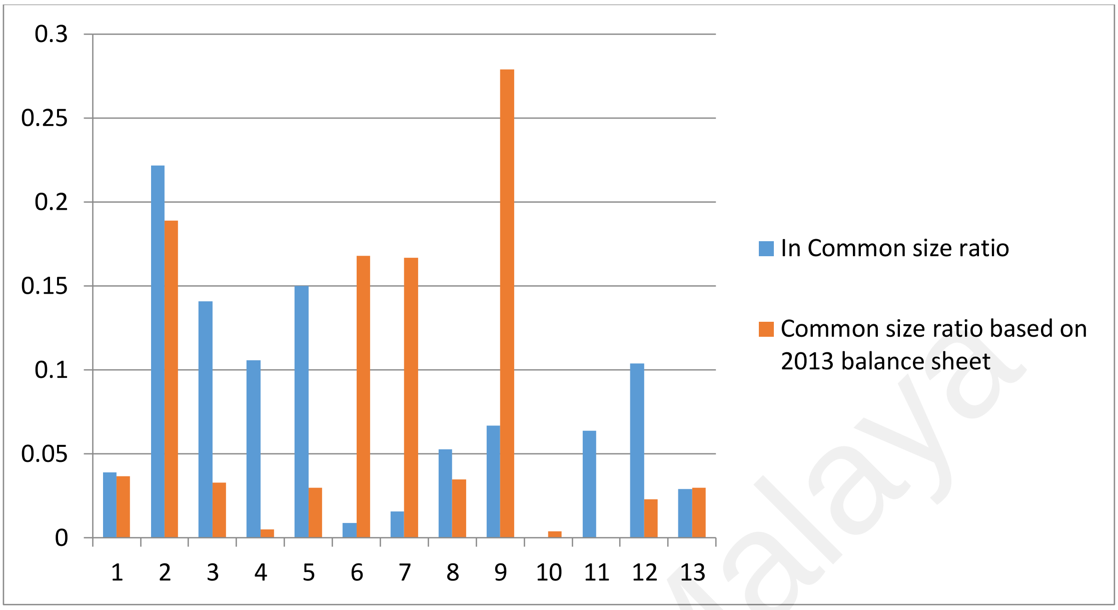


Figure 4.3: 2012, Proposed Liability Composition

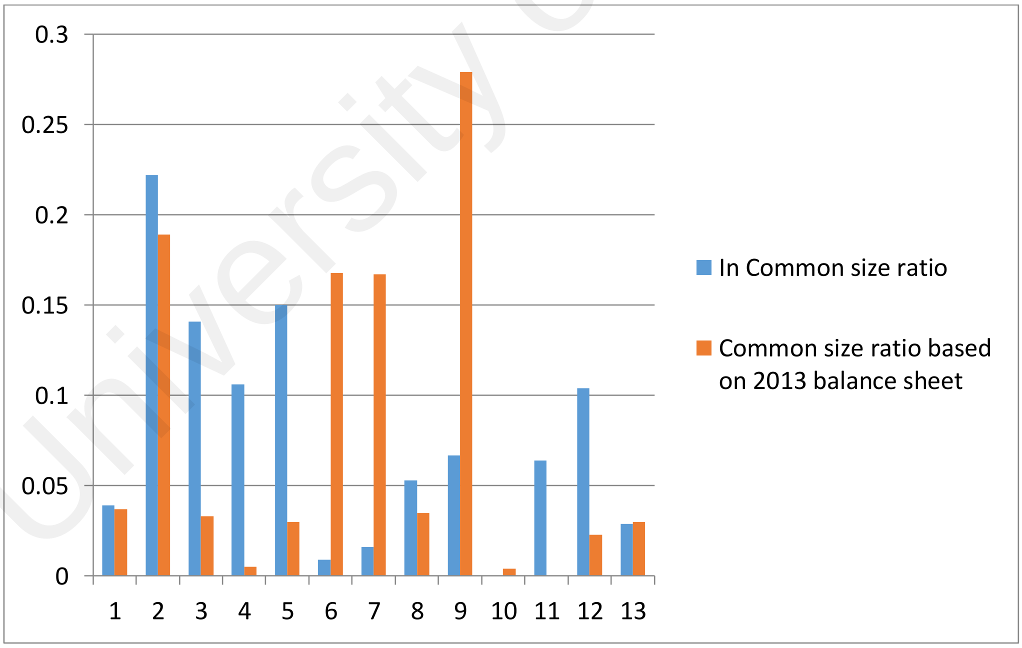


Figure 4.4: 2013, Proposed Liability Composition

Table 4.9: Comparisons between the Actual and Proposed Values for Assets and Liabilities in year 2012 And 2013, and the Common Size Analysis with Total Assets as Base Comparison

Assets						
Variables	2013			2012		
	Proposed allocations	In Common size ratio	Common size ratio based on 2013 balance sheet	Proposed	In Common size ratio	Common size ratio based on 2013 balance sheet
X1	703,326.05	0.016	0.086	1,441,535.51	0.039	0.037
X2	4,345,070.43	0.100	0.212	8,267,665.80	0.222	0.189
X3	1,912,066.37	0.044	0.030	5,258,088.51	0.141	0.033
X4	671,135.15	0.016	0.006	3,958,715.40	0.106	0.005
X5	28,829,382.38	0.666	0.019	5,587,735.41	0.150	0.030
X6	225,851.16	0.005	0.288	335,141.32	0.009	0.168
X7	308,639.64	0.007	0.005	597,817.00	0.016	0.167
X8	873,428.09	0.020	0.028	1,966,996.40	0.053	0.035
X9	1,681,264.78	0.039	0.287	2,501,054.86	0.067	0.279
X10	1,204,506.33	0.028	0.001	-	0.000	0.004
X11	734,808.37	0.017	0.001	2,378,098.98	0.064	0.000
X12	1,462,314.97	0.034	0.030	3,870,563.96	0.104	0.023
X13	309,067.28	0.007	0.006	1,068,245.85	0.029	0.030

Liabilities						
Variables	2013			2012		
	Proposed	In Common size ratio	Common size ratio based on 2013 balance sheet	Proposed	In Common size ratio	Common size ratio based on 2013 balance sheet
Y1	25,997,665.15	0.601	0.054	14,898,006.51	0.400	0.052
Y2	2,846,040.78	0.066	0.047	44,939.83	0.001	0.058
Y3	477,042.52	0.011	0.440	277,023.17	0.007	0.347
Y4	2,210,102.14	0.051	0.289	14,650,939.28	0.394	0.308
Y5	2,604,105.98	0.060	0.039	907,821.50	0.024	0.108
Y6	65,399.20	0.002	0.036	503,072.70	0.014	0.023
Y7	459,761.45	0.011	0.004	206,652.90	0.006	0.010
Y8	6,007,185.64	0.139	0.012	3,590,131.59	0.096	0.014
Y9	-	0.000	0.000	244,169.63	0.007	0.000
Y10	830,164.92	0.019	0.054	453,790.66	0.012	0.061
Y11	-	0.000	0.001	6,545.05	0.000	0.000
Y12	-	0.000	0.006	376,418.71	0.010	0.006
Y13	1,763,393.21	0.041	0.017	1,072,147.47	0.029	0.013

It should be noted that the suggested and actual assets, liabilities and equity mix deviate in reality because results generated by the model is determined and defined by the constraints confining the number of potential solutions given by the ALM model. This follows the global minima search function performed within a series of iterations until a solution is obtained. Therefore, it is compelling that the recommended asset liability allocation strategies should serve only as a benchmark for decision makers. Ultimate decisions should always be made after holistic contemplations to include other issues or factors not captured by the model. A good example to this is the sudden change in the current economic environment that could demand for a prompt need for contingent ALM strategy.

In this situation, the manager might need to decide quickly a contrasting strategy to overcome potential losses that may be caused by unfavourable market shifts. If the manager decides to preserve and continue with his current strategies, the bank may suffer potential losses which is highly futile and is usually the cause of an unfavourable outcome due to invalid or poor decisions. The study proposes a method to overcome these unfavourable shocks through sensitivity tests. For example, interest rate sensitivity test is suggested in order to have a more meaningful asset liability mix after considering several aspects of economic outcomes. Apart from interest rate risks, sensitivity tests can also be performed to investigate the outcome of market rate changes such as shifts in consumer preferences in banking and innovations by competitors. Credit risk assessments can also be done using stress tests together with other main factors affecting an Islamic bank‟s balance sheet performance.

The sensitivity test is used on returns generated for the „Financing, Advances and Others‟. These results are discussed with three *foci* assumptions deduced for a BIMB‟s ALM model. These assumptions include asset prepayment rates and the behaviour of non-maturity deposit account and the elements which are fluctuating market interest rate. These effects were considered by making a general assumption that the changes explored in this research for sensitivity analysis are included in the experiment using changes in market rates by plus or minus 100 *b.p.*

It was observed that higher allocation should be catered to financing based on *murabahah* and least to *tawarruq*. The generated suggestions could be based on the level of rates of returns earned by the bank in products offering. It has been observed that more efforts are executed by the bank to promote *murabahah* as a financing mode and to reduce *bai" bithaman ajil.* Moreover, with actual and expected results as well as the budget allocation to each kind of investment since there is no clear distinction between funds contributed by the GIA and SIA. Detailed discussions supporting the outcomes obtained in this chapter are retained for Chapter 5 for discussions and future research recommendations.

4.3.3 Proposed Weights for Financing, Advances and Others

As per our discussions in Section 4.5, we see that the proposed allocations had increased from 0.644[48] in year 2012 to 0.838 to year 2013. In justifying the need for increased allocation for this group of assets, we know that the relative per annum returns by offering products from this category could alleviates the bank‟s objectives in sustaining net operating margin, as thus boosting the groups income in general (BIMB, 2014). On the other hand, operating costs from the deposit side of can be minimised by attracting more capital from deposit products that are *mudaraba* based.

[48] The performance as a result for the suggested allocations for year 2012 should be ignored. Mentioned in Section 8.1, reasons for this exclusion was because of forecasts for 2013 performance revenue was conducted with allocation recommended using 2012 forecasted balance sheet.

As we have discussed previously in Section 3.8.2, this type of deposit provides the bank with lower cost capital compared to other types of liabilities and equity capitals. One can turn to results from the proposed allocation on performance revenue (i.e. target P1 in Table 4.8). In order to make the analysis more meaningful, one may perform the interest rate sensitivity test on the changes in the market rate and its outcome on the bank‟s net interest margin. The sensitivity analysis allows us to understand the outcome any occurrence, like the change in the market rates, and to look at how this will affect the asset and liability management process. In this regard, the sensitivity testing can also be used to ascertain flaws in a given model (in this case, the asset and liability management model). Should there be any weakness or the model turned out to bear insignificant contribution, the modeller can modify and take necessary remedial actions to improve the model‟s practicality.

The key in sensitivity analysis is to identify the main factors affecting the bank‟s internal rate of return while managing the assets and liabilities. Here, the main factor approached by BIMB which is reported in the annual reports is the market rate. The bank performed a test of ± 100 basis point (b.p) changes unto its capital to demonstrate the stability of its core capital with the market rate changes. To demonstrate the practicality of the proposed asset and liability allocations, the thesis will perform a sensitivity test of ± 100 b.p or an increase or decrease in the market rates by 1%.

The change in the market rates will result in the change on the bank‟s total portfolio return for the two portfolios, (1) financing, advances and others and, (2) investment securities are shown in Table 4.10. However, without appropriate and sensible assumptions, we might end up in complicated tests which could lead to an unworkable asset and liability model. There are three focal points in assumption settings for a bank‟s asset and liability sensitivity test. They are the (1) asset prepayment rates, (2) the behaviour of non-maturity deposit account and, (3) elements moving the market interest rate. The assumptions made for the first two points are important because they can affect the internal rates of the bank directly. In point one, the assets like loans and receivables follow a fixed rate for the one period (a year) observed regardless of the changes in the environment. As we know, the rates charged to the customers carrying these loans, financings may be based on floating rates. These rates changes according to the market and may affect the operating margin earned by the bank. In this test (the sensitivity test) we will assume that only the fixed rate (shown in Chapter 3, Table 3.3) are fixed for the two years to allow us a better assessment on the outcome of changes in the market rates by only one percent. Secondly, we assume that the assets and liabilities reported as at the end of the bank‟s financial year are fixed from the beginning of the reporting period. In short, we assume that the maturity for the assets and liability classes are same. This is because maturity structure will move the rates in the market differently.

Consider an example of the long and short term loans. They are priced differently according to the liquidity risk exposure. The third point concerns items that contribute to the movements in the market interest rates. In real, a researcher should consider the correlation between all factors including the fed monetary policies, exchange rates (that can affect demand for a particular currency, thus causing the interest rate to increase or decrease accordingly), plus other environmental factors that gives direct impact on the rates‟‟ movement. We consider only these effects by making a general assumption that the changes explored in this research for sensitivity analysis are included in the experiment using changes in market rates of plus/minus 100 *b.p* as the deviation range for the model‟s testing purpose. These returns are the results of sensitivity tests on assets in the „Financing, Advance and Others‟ category, in Table 4.9; asset category and „Investment Securities, shown in Table 4.10 in Section 4.7. From Table 4.9, we observed a proposed higher allocation for to financing based on *murabahah* and least to *tawarruq*. The generated suggestions could be based on the level of rates of returns earned by the bank in products offering[49]. We can also see more efforts taken by the bank to promote *murabahah* as a financing mode and to reduce *bai‟ bithaman ajil* in Table 4.10 below.

Table 4.10: Ratios of the *Shari'ah* Compliant Loan Types in Relation to Its Total Value of Financing, Advances and Others For Year 2012 and 2013

Products	Current portfolio composition for financing, advances and others			Proposed portfolio composition for financing, advances and others	
	Variables	2013	2012	2013	2012
Bai'bithaman Ajil	X2	0.378	0.319	0.120	0.344
Bai' al-'inah	X3	0.053	0.055	0.053	0.344
Ijara	X4	0.010	0.009	0.019	0.165
Murabahah	X5	0.035	0.051	0.794	0.233
Tawarruq	X6	0.515	0.283	0.006	0.014
Other modes of financing	X7	0.009	0.283	0.009	0.025
Total		1.000	1.000	1.000	1.000

4.3.4 Proposed Investment Assets Allocation

Same as the above, with the actual and expected results as well as the budget allocation for each balance sheet item, the allocation assumes that there no clear distinction between allocation for general investment accounts (GIA) and the specific investment accounts (SIA). Table 4.10 below details the allocation for each asset classes based on their level of maturities. The categories of assets are the held-to-maturity,

[49] The results could deviate from the intention of the strategic ALCO managers. In view of the fact that these are only the proposed results using the model, banks can alter the model easily to include constraints limiting or promoting certain asset and liability management activities depending on the needs and environmental changes. The flexibility of the model is an added advantage to decision makers.

available-for-sale and held-to-maturity assets. Analysis was taken without assuming the differences of the contents of these asset classes.

Whereas detailed analysis of assets portfolio allocation for these items were discussed in earlier section and the allocation results were tabled in Table 4.9. The multi-objective balance sheet management model suggests more capital allocation for the available-for-sale assets for year 2012 and 2013. Lesser allocation was proposed for held-to-maturity assets. Although the percentage allocations were somewhat different from the bank‟s current allocation, nevertheless the allocation density is consistent with the current allocation.

Table 4.11: Proposed and Current Balance Sheet Allocations for Held-For-Trading (HFT), Available-For-Sale (AFS) and Held-To-Maturity (HTM) Assets for Year 2012 and 2013

Items	Variables	Proposed allocation		Current allocation	
		2013	2012	2013	2012
HFT	X8	0.232	0.440	0.089	0.110
AFS	X9	0.447	0.560	0.907	0.878
HTM	X10	0.320	0	0.005	0.012
	TOTAL	1.000	1.000	1.000	1.000

4.4 An Overview of Results Analyses

Results of the study were discussed in this chapter for application of asset liability management model to the assets and liability portfolio problems of BIMB. Technical aspects of the model were also discussed by linking the results to the previous literature. Important features were also taken into account which were considered as a part of formation of model and then to comprehend the optimisation task. Further information regarding the bank‟s regulating and legislative environment was gathered about judgments and actions governing the operations of the Malaysian Islamic banks and financial institutions.

Proposed assets and liabilities composition and other comprehensive analysis guiding the understanding of the proposed results were also addressed in same section. Comparison was also done between suggested composition and bank‟s current returns. Return categories contained in this chapter are the bank‟s overall operating profit, returns from holding investment assets recommended by the asset liability management optimisation system, and profit obtained from giving finances to customers. Discussions to results obtained were discussed, using simulated proportions of assets and liabilities by the asset and liability model within the MATLAB R2009b environment were available. Results were arranged in the specific format which consists of the following aspects firstly the deviation values for years 2012 and 2013 (these deviations represents gaps between the expected and actual performances using BIMB‟s simulated and actual balance sheets for the asset and liability model and these values are given in millions of Ringgit Malaysia (MYR)).

Secondly, dummy values of 1 and 0 to denote manifestations of the under- or over-achievements for targets P1 to P5. Achievements using proposed asset and liability allocation for targets 1 to 5, denoted by P1 to P5. The Deviations for Target Constraints 2012 and 2013 were discussed and it was observed that, bank under-performed for target P1. Results for performance revenue (P1) and total assets growth (P4) are not applicable since plans for revenue and assets growth expected for year 2012 takes some time to be realised and that its effect could be observed in 2013. Model suggested the asset liability allocation which the bank will use to have experience over-achievement for its revenue performance target by MYR 486,760.48 million which is MYR 189,189.93 million more than its actual performance by MYR 297,570.55 million.

Further, it was detected that the excess overachievement for target P1 using simulated balance sheet with the asset and liability model recommends that the bank would continue to achieve this good results if it follows with the suggested allocation. Target P2 shows capital adequacy performance. Here, using the allocations simulated by the asset and liability model, the bank would experience over-achievements for both years. The actual and expected performance gap for capital adequacy target (P2). Target P3 represents the bank‟s achievement for its liquidity management. Working on the current allocation, the bank is experiencing an over-liquid position given an over achievement. The next target, total assets growth is denoted by P4, under-achievement of MYR 3,137,916.31 million for this target in the bank‟s actual balance sheet data was observed. Finally, target P5 which denotes the total deposit facility performance represents the bank‟s level of aggression in expanding deposit facilities available to support all funding needs in addition to maintaining the level of funds available for attractive investments.

The proposed current assets and liabilities compositions were made from the common size analysis and it was concluded that some of the deviations observed were significant while others were not significant. The proposed total financing, advances and others were estimated to increase from year 2012 to 2013. Satisfying the multiple objectives of the bank‟s asset liability management, the bank should increase its financing, advances and others portfolio.

4.5 Concluding Remarks

In summary, this chapter presents all results and with brief statistical comments. Implications related to these findings on BIMB are covered in Chapter 5 *DISCUSSIONS, IMPLICATIONS AND CONCLUSION* of this research. Results presented in Chapter 4 are discussed statistically. Justifications supporting implications and main findings are written in Chapter 5. Chapter 4 begins with financial ratio analysis, common size tests performed on BIMB‟s year 2012 and 2013 balance sheets and variance comparisons between actual and expected balance sheet performances for year 2012 and 2013. These variances are slacks and/or surpluses that resemble deviations in goal attainment for the 5 conflicting ALM objectives of BIMB. Returns derived for the model‟s formulation were derived from the asset liability composition calculated using specific methodology discussed in this chapter. Similarly, variances obtained and presented in this chapter were taken to compare the bank‟s expected and actual returns. The ALM multiple objective classes covered by the ALM model are BIMB‟s operating profit, returns from holding investment assets recommended by the asset liability system‟s optimisation, and profit obtained from giving finances to customers, total assets‟‟ growth, liquidity position and total deposit facilities provided by the bank. The prominent contribution of this research is the methodology taken to compare the actual and proposed composition for BIMB asset liability management problem as the model‟s validation. This methodology is conducted by few researchers in this field. For example, Belouafi (1993) performed similar analysis to validate his ALM model.

CHAPTER 5: DISCUSSIONS, IMPLICATIONS AND CONCLUSION

5.1 Introduction

This chapter embodies major findings and its role in answering the research questions of this study, contributions and implications to these findings, limitations experienced during the research, suggestions to delimit these challenges in the future, recommendations for further studies and a conclusion summarising the chapter and this study.

Literatures on asset liability management optimisation models within the banking operations have been approached in two different ways: (1) single-objective and (2) multi-objective optimisation. These models originated with from the famous Markowitz (1952) portfolio management concept. This research adopted the multi-objective asset liability optimisation for various religious and non-religious objectives of the Islamic bank. To accomplish the research objective consisting of *Shari'ah* compliant components and functions for an asset liability optimisation model, this research considers only the Islamic religion and investments objectives by BIMB. The subsequent section provides discussions relating to main findings with links to research question and objectives.

5.2 Overview of the Essentials: Research Questions, Objectives and Findings

This section summarises the achievement of the research questions beginning with the broad research objectives listed in Section 1.4 and the milestones pursued to meet these objectives. It compares the current achievement with the main findings of the literatures and then analysing such deviations, the section incudes comments or suggestions for improvements to enable repeatability or refutability of the model. It does not only provide directions for improvements but also outlines the strength or weaknesses of the performance of this achievement. The summary is given in Table 5.2.

The research adds value by having a model that considers only *Shari‟ah* compliant transactions, activities and investments. At the same time, marginal religious objectives such as additional yearly charitable funds allocation on top of *zakat* in modeling the asset liability management objective constraints for BIMB. This is a unique aspect compared to conventional optimisation model. With this model, BIMB is able to put aside a pool of funds as part of their strategic plans in promoting socially responsible activities. Besides, this fund can also be used to promote ethical investments to fund activities that are coherent with the efforts to strike a balance between the economy and the ecosystems as part of the corporate social responsibility initiatives. The corporate social responsibility goal which was established as one of BIMB‟s asset liability optimisation constraint can assist in strategic decisions and plans to support plans in line with the bank‟s pursuit for corporate social responsibility.

Additionally, the validated model incorporates important issues in generating profit from investments through the profit-loss sharing (*mudaraba*) concept. This importance is incorporated as one of the constraint function in the asset liability management optimisation model (see Expression 3.12 in Section 3.10.2.6). This mathematical model is implemented on actual data using BIMB‟s financial statements. Other Islamic principles like discouraged financial speculation was also considered in developing the optimisation model (see Expression 3.26 in Section 3.10.2.18). With this approach, the Islamic bank avoids unnecessary losses through speculation which could potentially lead to huge losses leading to bankruptcy. As an Islamic institution managing the wealth of the society, BIMB has the fiduciary and religious duty to ensure that investments chosen are *Shari'ah* compliant and contain any element that is not permissible by *Shari'ah*. Islamic banks are also encouraged to invest in companies or projects that conduct activities that will promote the wellbeing of a society. Besides having good governance in all aspects of operations, BIMB should avoid excessive risk taking with prudence placed on credit facilities available as source of capital and borrowing. Expression 3.23 (p. 202) in Section 3.10.2.16 (p.202) is a constraint function promoting BIMB"s solvency management. There are also updates on solvency management in the Islamic Financial Services Act (2013).

The general contribution of this research is an innovation in portfolio management through an optimisation model that is compliant with *Shari'ah* law. This model considers only *Shari'ah* compliant activities and focuses on Islamic-based societal value adding activities (see Expression 3.21 (p. 199) in Section 3.10.2.14 (p.199)) through strategic charitable goals. Since money by itself should not be used as a profit generating mechanism through financing facilities offered by Islamic banks like BIMB, the Islamic bank"s lending facilities should be abided by the *Shari'ah* law. A transaction is considered usufruct and interest-bearing if margins are charged on top of the principal amount due and that this amount adds to the previous unpaid amount. Thus, lending according to *Shari'ah* must be either approved by the Islamic law to be given out in the form of economic value adding financings or gifts to the poor in terms of entrepreneurial investments, education, health and to satisfy emergency needs based on *qard ‚ul hassan* or donation that promotes societal welfare through benevolence.

The research has successfully developed a multi-objective asset liability management model that is validated with the case of BIMB. This model is designed using MATLAB R2012b to ease future replications and reproduction for improvements that includes the incorporation of a function that reflects evolved regulatory needs. This model has been established based on wealth maximisation objective of the different types of equity capital providers of the Islamic bank. This study proposed improvements to be done to fine tune the model for a more efficient data processing and to improve the speed of convergence for quicker solutions. Besides, the quadratic assumption for a minima or maxima solution is established to enhance the applicability of a given optimisation problem. In real, the problem may have several points of minima or maxima (a problem with stochastic characteristics). Problems like these should be represented by functions incorporating complex statistics or probabilistic features. A good example explaining this is the nature of withdrawals from demand deposit accounts. These withdrawals can occur randomly, both in sizes and time of occurrence. Therefore, during low interest rate environment, investors prefer to have their funds invested in higher return investment vehicles as opposed to placing their money with the banks. Future studies are encouraged to have complete set of data from the bank treasury department in order to have a more robust and highly representative model for optimum portfolio decisions that provide asset allocation forecasts closer to reality.

The second research objective is achieved with two different sets of algorithms documented for this research. They are algorithms representing: (1) the processes performed by the optimisation system in finding the best convergence as part of the model‟s validation, (2) the steps representing research processes from data inputs to the final asset allocation weights. There two algorithms can discussions are found in Section 3.11. Better optimisation results can be achieved if the algorithms are validated with the help the industry experts or practitioners. These individuals can contribute by allowing the model‟s test to ascertain further its efficiency and potential flaws with actual data that are not available from the bank‟s financial statements. This type data is regarded as highly confidential by the bank. Future studies should consider the latest application of Basel III capital requirements, solvency, market, credit, and liquidity risks management with updates by Bank for International Settlement (BIS). Since this research uses BIMB‟s data from 2012 and 2013, the complete adjustments to comply with the new standard are not available. Basel III is implemented fully on 1st of January 2016 (Basel Committee on Banking and Supervision, 2015).

Research Objective Three (3) requires the research to identify a set of efficient asset liability allocation weights. This objective is achieved with results analysis, reviews and justifications presented in Chapter 4. Several efforts outlined in assumptions established in Section 3.12 are established to simplify the model. Future studies can maintain the parsimonious and phylogeny objectives in modeling by having a more sophisticated programming software. The assumptions in Section 3.12 can also be minimised by having higher levels of data that are not easily available (see *data collection challenges* on page 104). Because of this, liquidity management of the model did not mirror accurately the actual liquidity position of BIMB as opposed to the model established by Kusy and Ziemba (1986) as well as other prominent researchers of this field. In order to overcome this drawback, the research suggests that higher level of data should be obtained from industrial practitioners especially personnel who work with the bank‟s treasury department.

Table 5.1: Summary of Research Findings and Its Attainment of the Objectives of this Research

Research Objectives	Findings	Literature Review	Comments and Suggestions for Improvements
1. To establish an asset liability management model through multi-objective optimisation which reflects an Islamic bank‟s actual operating context and unique Islamic banking features in Malaysia. It should also be geared to the wealth maximisation of the different shareholdings of the Islamic bank in of this study (BIMB).	The multi-objective model has been validated by obtaining convergence for the model. The application of the model is able to provide sufficient level of accuracy to enable implementation for the Islamic bank‟s asset and liability management.	General convergence in the literature for optimisation models depend on the number and the types of optimisation objectives. It affects the time taken for such convergences. The percentages of convergence taken between the actual and the proposed model. The method is similar to testing the objectives with respect to multi-objectivity in asset liability management which is simulated in respect the quantum anneals of all possible solutions, which produces a set of *pareto* optimally acceptable solutions. The method works in a similar way with respect to the standard (single-objective) simulated annealing implementation, and produces a set of (potentially Pareto-optimal) solutions not dominated by any other solution generated by the algorithm so far.	The model was able to attain speedy convergence. The obtained results indicate the potential for efficient asset liability application of the suggested methodology for Islamic banks while maintaining religious requirements. The model was run tested several times to attain higher modeling accuracy. With quadratic assumptions, the efficiency of the model was enhanced. A common approach is to assume quadratic characteristics of the derivative changes at every point of the objective gaps between the target and actual performances while giving more emphasis on the nature of this convex problem. However, it should be noted that the model should reflect exponent or stochastic changes in variables such as the bank‟s liquidity and cash flow forecasts. Through higher order stochastic processes, and the advance

			computerised programming systems, the process can be completed within the shortest period. However, the because of data unavailability and full-participation of the treasurer would have affected the progress of the current study.
2. To document all the algorithms developed for the Islamic bank‟s asset liability management.	The developed algorithm for the current study can serve as test model for future research repetitions or for „battery test‟. This flexibility will provide potential improvement opportunities by other research from this field.	There are not many documentations of the optimisation algorithm especially in the area of balance sheet optimisation for Islamic financial institutions. This has motivated the current research to undertake such effort in documenting algorithms for the Islamic bank‟s balance sheet management. These are the documented algorithms that are similar to the algorithm of the current study. The documentation were done by; Zitzler, Deb, and Thiele, (2000), Srinivas and Deb (1994), Ankiah and Ravi (2015) in Shukla, Singh, and Shankar (2015). These related findings supports algorithm development which is based mainly on multi-objectives and decision ranking like the purpose of our Research Objective THREE (3). However, like Young, Tick, Towse Jr., Chang, Roy, Yse	The algorithm can be revised to incorporate triangulation method where interview is conducted to form themes of constructs for stochastic data collection apparatus as well as emerged objectives in the area of balance sheet management. A very recent challenge faced by the bank is the effort to prepare the balance sheet structure to comply with Basel III requirements.

		and Scowcraft (2002) documented algorithms and the apparatus for portfolios of many investors or decision makers, to represent multi-objectivity and constraints in decision making.	
		Other than the above, examples of the extended algorithms in the field are stated below: Approaches or algorithms focusing on the balance sheets; Consigle and Dempster (1998), Kouwenberg (2001), Gondzio and Kouwenberg (2001). Non-dominated multi objective optimisation using genetic algorithm by Srinivas, Deb and Deb (1994). Probabilistic linear programming algorithm for managing interest rate risk: Lai and Hwang (1993) Algorithms for the prediction of financial performance: Jiang, Xu, Wang and Wang (2009)	
3. To identify an efficient range of asset allocation for BIMB – a prototype of a multi-objective asset liability management model.	The suggested allocation has been documented. The allocation method assumes that both the Specific Investment Account (based on the *musharaka* concept) and General Investment Account (based on the	This section includes literatures supporting the need for asset (especially GIA and SIA) and liability for the Islamic banks which is, within the knowledge of this research, ignored by the current literature. Karim (2001); Sundararajan, (2007); The differences between the	As an approach to reduce the model‟s complexity, we assumed that the maturities of the investment assets are same vis-à-vis the best allocation between the available-for-sale, held-for-trading and held-to-maturity assets.

	mudaraba concept*)* are the same. This assumption is important in ensuring that the model accounts for only investments that are preferred by the Islamic Economic thought (Gundogdu, 2009; Gundogdu, 2016; Uusmani, and Taq Usm n , 2002).	GIA and SIA funds were considered (Karim, 2001). Having the above modes of financings, Islamic banks are less exposed to credit risk (Moisseron, Moschetto, and Teulon, 2015; Samad, 2004; Zarrouk, Daoud, and Moualhi, 2016). In addition to that, latest researches by Bacha, Mirakhor, and Askari (2015), Hanif (2015), and Sapuan, Sanusi, Ismail, and Wibowo (2015), proved that financial institutions with the above profit sharing schemes demonstrated higher profits. Sapuan, Sanusi, Ismail, and Wibowo (2015) were able to show increasing returns between contracting parties under such schemes through the *shuratic* process or mutual consultation between all parties involved in the investment decisions.	However, the model did capture the liquidity requirement as per the guidelines on liquid assets management, within a model that reflects that minimum and the maximum allocation constrained in the soft optimisation constraint functions.

The above objectives are a merge of research questions raised in Section 1.4 on page 17. These questions are categorised according to the three main research objectives explained in Section 1.4. Clearer targets are formed from this merge. The specific research questions outlined in Section 1.4 are;

1) What are the baseline classical and contemporary literatures supporting the multi-objective asset liability optimisation modeling for the Islamic bank in Malaysia?
2) What would be the design or structure of the modeling stages and algorithms for the multi-objective asset liability management optimisation model for the Islamic bank in Malaysia?

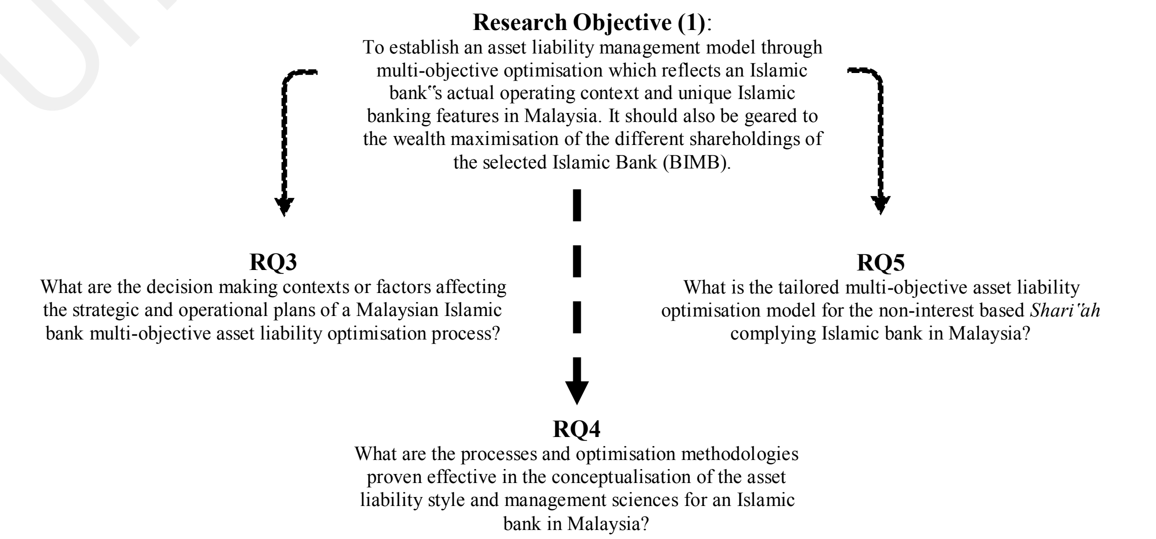
3) What are the decision making contexts or factors affecting the strategic and operational plans of a Malaysian Islamic bank multi-objective asset liability optimisation process?

4) What are the processes and optimisation methodologies proven effective in the conceptualisation of the asset liability style and management sciences for an Islamic bank in Malaysia?

5) What is the tailored multi-objective asset liability optimisation model for the non-interest based *Shari'ah* complying, Islamic bank in Malaysia?

6) What is the ideal set of optimum asset liability mix for BIMB using the multi-objective optimisation model?

The goal accomplishments and answers to these questions are discussed above with Table 5.1 to explain these achievements and comparisons performed on findings of previous studies. A diagram from Section 1.4 is repeated here in Figure 5.1 to show explicitly the relationship and the proposed solutions to these questions. Again, the relationship between the research questions and solutions are explained with justification in this section.



Research Objective (2):
To document all the mathematics *algorithms* (under MATLAB R2012b‟s programming environment) for the asset and liability management optimisation model using BIMB as the model‟s prototype and validation.

RQ2
What would be the design or structure of the modeling stages and algorithms for the multi-objective asset liability management optimisation model for the Islamic bank in Malaysia?

RQ1
What are the baseline classical and contemporary literatures supporting the multi-objective asset liability optimisation modeling for the Islamic bank in Malaysia?

Research Objective (3):
To identify an efficient asset, liability and equity composition itemised on the balance sheet of BIMB. BIMB is taken as prototype to validate the model. The model is flexible to be customised to suit the unique operational and strategic needs of other Islamic banks in Malaysia.

RQ6
What is the ideal set of optimum asset liability mix for BIMB using the multi-objective optimisation model?

Figure 5.1: Research Objectives and Questions for a Clear Illustration of its Linkage to Solutions Above

5.2.1 Main Findings: Contributions to the Pool of Knowledge

The research adds value by having a model that considers only *Shari‟ah* compliant transactions, activities and investments. At the same time, marginal religious objectives such as additional yearly charitable funds allocation on top of *zakat* in modeling the asset liability management objective constraints for BIMB. This is a unique aspect compared to conventional optimisation model. With this model, BIMB is able to put aside a pool of funds as part of their strategic plans in promoting socially responsible acts. Besides, this fund can also be used to promote ethical investments to fund activities that are coherent with the efforts to strike a balance between the economy and the ecosystems as part of the corporate social responsibility initiatives. The corporate social responsibility goal which was established as one of BIMB‟s asset liability optimisation constraint can assist in strategic decisions and plans to support plans in line with the bank‟s pursuit for corporate social responsibility.

Additionally, the validated model incorporates important issues in generating profit from investments through the profit-loss sharing (*mudaraba*) concept. This importance is incorporated as one of the constraint function in the asset liability management optimisation model (see Expression 3.12 in Section 3.10.2.6). This mathematical model is implemented on actual data using BIMB‟s financial statements. Other Islamic principles like discouraged financial speculation was also considered in developing the optimisation model (see Expression 3.26 in Section 3.10.2.18). With this approach, the Islamic bank avoids unnecessary losses through speculation which could potentially lead to huge losses leading to bankruptcy. As an Islamic institution managing the wealth of the society, BIMB has the fiduciary and religious duty to ensure that investments chosen are *Shari'ah* compliant and contain not any element that is not permissible by *Shari'ah*. Islamic banks are also encouraged to invest in companies or projects that conduct activities that will promote the wellbeing of a society. Besides having good governance in all aspects of operations, BIMB should avoid excessive risk taking with prudence placed on credit facilities available as source of capital and borrowing. Expression 3.24 (p. 202) in Section 3.10.2.17 is a constraint function promoting BIMB‟s solvency management. There are also updates on solvency management in the Islamic Financial Services Act (2013).

The general contribution of this research is an innovation in portfolio management through an optimisation model that is compliant with *Shari'ah* law. This model considers only Shari‟ah compliant activities and Islamic-based societal value adding activities (see Expression 3.21 in Section 3.10.2.14) through strategic charitable goals. Since money by itself should not be used as a loan, it should not be used as a profit generating mechanism through interests placed on the amount of capital lent. Therefore, as an Islamic bank, BIMB should comply with only *Shari"ah* approved loan process. Alternatively, the bank may contribute financially to the poor entrepreneurs for economic value adding investments like the education, health, emergency needs financing based on *qard „ul hassan* or *hibah* that focuses on promoting societal welfare through the act of benevolence and care.

5.2.2 Main Findings: Evidences and Assertions for BIMB

This section compares the major findings obtained by this research, results or allocation suggestions derived from the asset liability management model (Section 5.2.1). Discussions and justifications are backed by sources from the local news, credential media like the online reports by the independent rating agencies in Malaysia. This method (comparisons for suggested solutions through simulations, also known as the textual analysis, is important for social science studies (Fairclough, 2003).

To begin with, we first look into the simulated allocations which produced both favourable and unfavourable deviations between actual and expected targets. The favourable deviations were gathered for the performance revenue, capital adequacy, liquidity and total deposit facilities for both years. However, it was unfavourable for the total assets growth achievement. One possible contribution to this deviation could be the year that the data collection was done. Since data collection was done in years 2012 and 2013, it was reported in the Quarterly Bulletin of Bank Negara Malaysia that there was a decline of 0.2% in the growth of the finance and insurance sector for these two years. The overachievement of the capital adequacy target provides a good indicator that the bank"s effort in beefing up capital adequacy requirement under Basel III can be met. All banks are required to comply with the new Basel requirements stipulated in Basel III, that is, to carry at least the total common equity tier 1 (CET1) ratio of 4.5%. This ratio has to be maintained at all times (Basel Committee on Banking Supervision, 2015).

The disclosure of this type of compliance starts on the 1st January 2015. Besides, with suggestions from the ALM model, the bank showed better liquidity position than what it could actually achieve with its current balance sheet position. There was improved liquidity for year 2012, but not in year 2013. This finding is consistent with Samad and Hassan (1999)‟s study. The authors were not able to refute the hypothesis which states that BIMB will be less liquid in subsequent years when the bank matures (i.e. 2012 and 2013). These results are obtained based on the suggested asset liability allocation suggested by the optimisation model. In actual, RAM (2013) reported that the bank has been very liquid (measured by the total financings to deposit ratio, also in Section 4.2.2 of the thesis). This discrepancy arises due to the lack of precision in the data collected. For example, the portfolio assets optimisation model by Friend and McCrory (2000) and Kuzy and Ziemba (1985) were improvised by including the timing of cash flows as the measure of liquidity instead of the total value of financing and/or deposits which is assumed constant and a sufficient representation for a single period analysis in this study due to difficulty in data collection.

Tackling the results of underperformed total assets growth (a growth that was under the target growth percentage of 15%, reported by the Maybank Investment Bank on 16 April 2013 (Maybank Islamic Bank Research Report, 2015, RAM, 2014)), BIMB has been in a deal to negotiate the terms of amalgamation between the bank and Malaysia Building Society Berhad (MBSB) somewhere in February 2015 to boost its size, in terms of total assets (Thestar.com.my, 2015).

BIMB"s goal to widen its market share through increase of the automated teller and cash depositing machines nationwide have to be accompanied by efforts to promote awareness about the bank, its products and services through additional spending in marketing and promotion activities. The slack in total assets growth target performance is suggesting also that the bank was undergoing corporate restructuring which requires cash and/or additional capital acquisition. Therefore, the bank would have performed better if its cash flows are not constrained by the changes in its operating environment. If the simulated capital investment allocations (such as giving more emphasis on increasing assets in quality financings and money market instruments), the bank would achieve the suggested total assets growth. The growth is fostered through the accelerated growth in these two forms of assets than the growth of the 85% of the total values of deposits for years 2012 and 2013.

Table 4.8 (p. 236) in Chapter 4 shows this explicitly in which the total deposits target deviating negatively from goal. Table 4.9 (p. 248) provides clearer analysis of the above deviations with target results achieved using actual and simulated asset and liability proportions which are in monetary values rather than in percentages (Klemkosky, 1973; Lorie, 1968; Friend and McCrory, 2001). Differences between the two assets and liability portfolios for 2012 and 2013 (using actual and simulated allocations) can be seen more clearly through comparisons using market values than percentages.

In 1968, the Bank Administration Institute report was produced and documented by several "blue-chip" researchers in the field of finance like James Lorie, Kalman Cohen, Joel Dean, David Durand, Eugene Fama, Lawrence Fischer, and Eli Shapiro. However, the market values of BIMB funds are not available because all specific asset classes and their accurate holding periods will have to be identified. The current research lacks highly accurate data such as these, and that the annual report does not contain such precision. Only adjust values of available-for-sale assets (through recognizing the other comprehensive income or losses in the derivation of "other comprehensive income" section) (IAS 39, 2004).

Table 4.6 in Chapter 4 contains analysis of the simulated allocations for the different *Shari"ah* compliant financing, advances and other loans for 2012 and 2013. The study concluded that there should be more allocations given to financing type based on the *bai"bithaman ajil* and *bai" al-inah*, for year 2012 and *murabah* concepts as opposed to more *tawarruq* based financing in year 2013. The simulated allocations for year 2012 are the same for both simulated and actual allocation. However, it should be reminded that results gathered for Table 4.9 were the outcome of applying values from the balance sheet for years 2012 and 2013. The new focus based on the revised *Shari"ah* scholars and Board"s preferences have not been made explicit at the time the data was gathered. The currently popularized most highly preferred mode of financing.

It should also be noted that the different modes of financing (i.e. working capital, housing loan, hire purchases, personal loans and so on) do affect the choices of underlying *Shari"ah* based concepts, which in turn affects the raking of the most preferred type of financing analysed in this study. As outlined in Chapter 5, this study assumes that the modes of financing based on the different underlying *Shari"ah* concepts should be viewed generally for all financing objectives rather than classifying them into specific loan categories because of the limitation in data, the data that is available for this study. Section 5.3.1 will provide further discussions on the results generated by various models in the literature. These discussions will include significant shift in the preference for specific modes of financing before and after innovations in Islamic products and services.

Table 4.10 gives the various proportions of assets held for portfolios consisting of the held-for-trading (HFT), available-for-sale (AFS) and held-to-maturity (HTM) investment assets for 2012 and 2013. These allocations were also the cause for the bank‟s improved liquidity position, given that the bank follows suggest asset holdings based of the specified classes of assets above. BIMB has not only elevated its liquidity performance, it was also able to include new and improved quality capital requirement under Basel III, the available-for-sale securities forces not only big banks, but also financial institutions with significant available-for-sale portion of investment to count gains and losses in the values of these available-for-sale in their Tier 1 common equity.

This led the bank to report volatile gains or losses in times of interest rate fluctuations (especially in situations of rising market interest rates). On the other hand, if the bank holds more held-to-maturity assets, the loss of value will not affect the bank‟s capital levels, thus, making held-to-maturity assets more attractive and enticing than the available-for-sale securities (Rapoport, 2015). Comparing the actual and simulated asset holdings, the simulated method leads to reduced available-for-sale from a proportion of 0.907 (in year 2013) to 0.447 and an increase in the portion allocated to the held-to-maturity asset class from 0.005 to 0.320 out of the total portfolio value (Refer to Table 4.10, Chapter 4). Not only did the proposed framework is able to beef up the bank‟s capital quality, it also allows BIMB to improve their financial ratios even in times of rising-interest-rate environment (Rapoport, 2015). These results will not be meaningful in the decision making process if studied in *silos*. A useful analysis should be accompanied by associations between the current findings and those documented in the literatures alike. Section 5.3 deliberates this objective and it begins with the main literature of this research.

5.3 Comparison of Findings with Previous Models

This section provides comparisons between results attained with the current model and other similar multi-objective balance sheet management models in the literature (also discussed in Chapter 4). The discussions below refer to Table 5.1 and its summarised contents.

Mehri and Jamshidinavid (2105) designed a mathematical model adopting linear programming with goal functions, taking Eghtesade-Novin Bank to validate their model. Though their approach is similar to this research, they used an enabled toolkit/ software with LINGO to perform the analysis. Therefore, algorithms directing the flow and structure of the optimisation process are not documented. Using a tailored optimisation model customised to suit the operational context of BIMB; this research is able to include specific constraints that are adjusted to suit BIMB"s operating concerns such as charitable and specific wealth maximisation to certain group of equity capital provider.

Another similar study performed by Vishwanathan *et al.* (2014) using goal functions and included a stretch of 15 years to analyse the strategic asset liability management performance for the Indian banks. However, the authors considered only the Indian banking industry making decisions on whether the banks included are full-fledged *Shari"ah* complying institutions difficult. The authors performed similar techniques in developing their optimisation model which was then used to compare the asset liability performance of the Indian banks.

A study conducted by Belouafi (1993) was successful in developing an optimisation model similar to this study. Although so, the model"s validation technique undertaken by the author is unclear. This research improved the model"s validation and reporting which is accompanied by the algorithm presented in Section 3.11.

Additionally, the author developed a model that is suitable to the Kuwait banking environment. This research differs by focusing only on the Malaysian Islamic bank. This difference alone would determine the governance BIMB‟s banking operations in this country.

Although the scope of study by Bahloul and Abid (2013) is akin to this research, the authors engaged the analytical hierarchy process in their goal functions to model portfolio returns for their French investors. Investors with *Shari‟ah* objectives are different from most interest-based income investors because their significant portion of returns and/or their objective of investment are to obtain interest repayments from the credit notes of institutions where they generate their current streams of fixed returns as source of income. This study develops a model that is customised to the Islamic banks in Malaysia. Operational requirements by Bank Negara Malaysia are incorporated ion the optimisation model.

Hane, Emrouznejad and Ouertani (2014) shared similar research objectives though their research was mainly about the use of a pre-developed economic model that is data envelopment analysis (DEA) to measure the Islamic bank‟s technical efficiency. This research however is focused at developing the customised asset liability management model represented by its deterministic characteristics for the Malaysian Islamic bank (using BIMB to validate the model). Moreover, their research is conducted on banks from the Gulf Cooperation Countries (GCC), a sample different from the operational context of this study.

Another independent study performed by Ar and Kutaran (2013) on banks in Turkey was performed using a model developed by Charnes-Cooper-Rhodes model (See Charnes and Thore, 1966). The authors performed portfolio optimisation performances among 13 Turkish banks using a pre-developed model. Compared to this study not only a set of algorithm for the optimisation process was established but also documented. The outcome of this study differs from Ar and Kutaran‟s (2013) approach because the output of this research is the optimisation model that can be used by future researchers for studies based on comparisons of asset liability management performance or by the industry practitioners so that they can replicate flexibly the optimisation model for a customised balance sheet management for an Islamic bank.

Kusy and Ziemba (1986) on the other hand developed a model that is somewhat similar to this research. However, significant differentiating features of their model compared to this research is the incorporation of stochastic inputs, the enhanced approached to balance sheet management. The research addressed this data collection problem due to data collecting challenge and replaced with justifications from the literature on the inclusion of the deterministic programming approach to overcome this challenge. Furthermore, their study focuses on model development for an interest-based investment bank, a significant feature that is non-permissible by *Shari'ah*.

A different approach in modeling the asset liabilities optimisation model was conducted by Giokas and Vassiloglou (1991) is also reflective of the current model developed for the banking institution. Similar to Kusy and Ziemba‟s (1986) study, the authors modelled the linear programming goal optimisation problem for an interest-based conventional bank in Greece. An approach undertaken that is alike to this study is the use of deterministic linear programming approach so that the process can be computational tractable. Nevertheless, *Shari'ah* compliance is not the emphasis of this study.

Table 5.2: Summary of Main Findings in the Literature that is Similar to the Study

Authors	Title	Sample/ model	Originality/ contributions	findings
Mehri and Jamshidinavid (2015) in Halim, Karim, Fahami, Mahad, Nordin, and Hassan (2015).	Designing a mathematical model of asset and liability management using linear programming with goal functions (Case study: Eghtesad-e-Novin Bank)	Eghtesad-e-Novin Bank Linear programming with goal functions LINGO software	The inclusion of the bank and shareholders‟ wealth equality constraint	The authors compared the results obtained by the model and the bank‟s actual performance. There are two under-achieved objectives, the liquidity and capital adequacy requirements.
Vishwanathan *et. al* (2014)	Modeling asset allocation and liability composition for Indian banks	Indian industry bank from 1995-2009 as sample for study Linear programming with goal functions	Sensitivity analysis for robust check, using current and savings account and interest rate changes.	The model is able to generate optimality The research objective is met, that is developing and efficient model with the graphical user interface (GUI) for the bank‟s balance sheet management.
Belouafi (1993)	Asset and liability management of an interest free Islamic bank	Comparisons between of the balance sheet management between Kuwait Finance House and Jordon Islamic Bank Single and multi-objective liner models. Used the MOOM and SOOM models.	Performed comparisons between banks to check models‟ efficiency	The two models produced different results The MOOM model is more efficient than SOOM.

Bahloul and Abid (2013)	A combined analytic hierarchy process and linear programming with goal functions approach to international portfolio selection in the presence of investment barriers	Multiple criteria in decision making which combines the analytic hierarchy process (AHP) and the linear programming with goal functions (GP) model. French and US investors	Performed comparisons of results obtained using both AHP-GP and CAPM models. Optimisation which considers investment barriers and international investment portfolio selection	They found that the portfolio international weights are different; results obtained from the AHP-GP and CAPM models. Results showed that the values from the AHP-GP are lower than those calculated on the basis of value-weighted market portfolios.
Hane, Emrouznejad and Ouertani (2014).	Technical efficiency determinants within a dual banking system: a DEA-bootstrap approach.	Comparative analysis using bootstrapping model Analysis of the efficiency of Islamic and conventional banks in Gulf Cooperation Council (GCC) countries. They performed the comparison study using data collected from the bank‟s 8 years‟ financial statements. Comparison was made between Islamic and conventional banks.	Bootstrapping method was used. It is common when the researcher is having small sample of study. Performed analysis on the GCC banks.	They documented that the average technical efficiency of the Islamic banks outperformed the conventional banks. This was not the case after year 2008. The technical efficiency of the conventional banks is higher than the Islamic banks. The Islamic bank however, showed an up trending, and more stable performance in the case of technical efficiency. This is especially significant when the results showed that Islamic banks are better at withstanding the 2007/2008 sub-prime financial crisis.

Ar and Kurtaran (2013).	Evaluating the relative efficiency of commercial banks in Turkey: An integrated AHP/DEA approach	They performed the portfolio optimisation on the sample of 13 commercial banks in Turkey for year 2011. Used Analytic Hierarchy Process (AHP) and Data Envelopment Analysis (DEA). Performed tests based on samples categorised by the foreign, state-owned and private-owned commercial banks.	Comparisons based on renowned models in the portfolio optimisation literature. Samples tested are categorised by the foreign, state-owned and private-owned commercial banks.	The results of their study were that the state-owned commercial banks are efficient using two renowned models in portfolio optimisation model (i.e. Charnes-Cooper-Rhodes model) and (Banker-Charnes-Cooper model). The foreign-owned banks on the other hand have lower efficiency scores than the state-owned and private-owned commercial banks.
Kusy and Ziemba (1986)	A bank asset and liability management model.	Incorporating the concepts of uncertainty in cash flow, cost of funds and return on investments, a bank must determine its optimal trade-off between risk, return Liquidity management	stochastic decision tree (SDT) model developed by S. P. Bradley and D. B. Crane	The model is operationally feasible compared to deterministic it is also computationally more tractable on realistically sized problems than SDT, and simulation The showed significantly the ability of the simulated models in promoting better balance sheet management policies
Giokas and Vassiloglou, (1991).	A linear programming with goal functions model for bank assets and liabilities management	Multi-objective constraints maximisation, using mathematics programming, captures complexity of problem with the raking objectives (prioritization). Application on the commercial Bank of Greece Linear programming with goal functions model	Using multi-objective linear programming with goal functions model, on Greece bank	The model can maintain computational tractability although it is simplistic The use of static data is sufficient in determining the policies of a bank‟s asset liability management.

Source: Developed for the use of the thesis‟ results comparisons with other similar studies in the literature.

In summary, future researches aimed at replicating or reproduce this study or the model established for this purpose should always begin the financial modeling process starting with the Islamic or commercial bank‟s objectives. It is common to begin with the investor‟s profile in an investment portfolio management (in this case is the portfolio of assets and liabilities, structuring the banks" balance sheets). Then, algorithms are generated to instruct the system in designing and developing formulas (algebraically) for the use of the programming software (which depends on the bank‟s request or the researcher‟s familiarity with the systems and capabilities of the software systems). The efficiency of the model is crucial because a lag caused by delay in results generation due to complexity in inputs or algorithms will bring further delay and inaccuracies, depending on the severity of such lag. Without doubt, complex models may not necessarily contribute to improved output efficiency. It only meant that dynamism or dualism in the stages of cash flows characteristics that can be captured and considered in the model formulation.

5.4 Limitations, Delimitations and Prospects for Future Research

Emerging methods using MATLAB programming environment for optimisation problems are aplenty. This tools ranges from convex programming with TOMLAB© and the Genetic Algorithm functions can be considered depending on the users" preferences which include user interface friendliness, comprehensiveness in robust statistics and computing, available number of options and capabilities and most importantly, the general computing characteristics and better representation of the problem studied. Researchers should however refer to several alternative models before resorting to rely on conventional software that have built-in commercialised optimisation tools. A suggestion to note before selecting programming software for financial modeling is, first to understand the complication of the problem studied, whether there is a need for sophisticated software to aid complexity in computational statistics and budget allocated for this purpose.

Users with technical background and skills in programming and computational mathematics can modify the programming codes of the commercial built-in software. They can modify and customise these tools to reflect the environment of an optimisation problem. This knowledge is important to enable a more robust optimisation process and increased precision in the forecasted weights for asset allocation. Additionally, the functionality of a model depends on the set of assumptions established to enable the model‟s implementation. These assumptions should promote the model‟s parsimonious and phylogeny (Chaturvedi, 2010; Venkataraman, 2009).

There are several limitations identified for this research during the process of fulfilling the research objectives outlined in Section 1.4. Based on the ontological financial modeling process, most variables of the asset liability management model are simplified for computing purpose. This approach is important to maintain computational tractability (Chaturvedi, 2010; Venkataraman, 2009; Zenios and Ziemba, 2007).

Nevertheless, it should be noted that future studies should establish models that mirror closely the actual or real asset liability management environment of a bank. This can be achieved by performing repeated interviews and working closely with the treasurer or asset and liability committee or ALCO. The challenge arising from this research is the difficulty in obtaining full attention from the treasurers and ALCO committees that are highly occupied with their daily roles and responsibilities. To overcome this challenge, reasonable and sufficiently valid alternatives were established and adopted with justifications and support from literatures incorporating the deterministic single period inputs from the bank‟s financial report (Belouafi, 1993; Giokas and Vassiloglou, 1991). It was also mentioned in Chapter 2 this approach has been adopted by a significant number of researches to qualify for an academic model to the asset liability management practitioners (see Poorman, 2008). This approach has also been taken to substitute priority weights of relative importance for the decision hierarchy process using different sets of hard and soft (binding and non-binding) goal constraints in asset liability optimisation model. It is advised that future researches should undertake similar studies with greater emphasis on data availability check before attempting this study.

To improve the accuracy of the optimisation model, researchers should consider modeling different cash flow timings because this affects liquidity management which eventually leads to different asset liability performance. Viswanathan, Ranganatham, and Balasubramanian (2014), and Charnes and Thore (1966) incorporated the different timing of the cash flows by assigning different probabilities to these cash flows to represent different cash flow occurrences within the period studied. Additionally, one can adopt a more robust approach for an improved optimisation model by running tests to validate the model using the neural network concept from physics and computational mathematics.

The MATLAB programming software can be used to cater for this purpose. With the results generated by the neural network, one can compare the significance of these deviations. Besides, Etter and Kuncicky (2011) in their book "*Introduction to MATLAB*" suggested simulating the model for the model‟s validation. One can compare the patterns and behaviour of the two types of model‟s outcome (using simulated and real data) to check for significant discrepancies, if exists, between the two outputs. Readers should also note that the research has been improvised by using monetary values for comparisons between the portfolios of asset and liability for years 2012 and 2013, both actual and expected performances (Friend and McCrory, 2001). This important finding was also emphasised in the report by 1968 Bank Administration Institute report for the need to evaluate the performances of the fund managers through assessments based on the monetary values of the portfolios instead of the return percentages achieved by these portfolios (Dietz, 1968; Klemkosky, 1973; Friend and McCrory, 2001).

The author of this thesis is grateful to a few respective individuals who contributed to a very significant extent in all stages of the design of this study, the data collection apparatus and during the programming stage using MATLAB. The specifications to all indebtedness are acknowledged in the acknowledgement section of the thesis.

This chapter covers the discussion on major findings and comparisons of the current model with similar models based on literary to suggest future research scope. This chapter has incorporated and discussed the multi-objective asset liability optimisation technique which is originated from famous Harry Markowitz portfolio management model. The rational for using this model is based on various religious and non-religious objectives of the Islamic banking. To meet these objectives, the non-interest principles of the Islamic banking are considered, thus making asset liability management of the Islamic banks somewhat different than the conventional interest-bearing banking. One of the unique limitations explored for BIMB is the annual strategic plans for the share of profit contribution to charitable organisations. Islamic ethical standards are required to be maintained conducting this research on such constructs because it is the duty of every Muslim to abide by the ethical standards which are based on interest free transactions and allocation of resources in a manner to contribute towards betterment for society.

Chapter 5 includes discussions and justifications that are backed by sources from the local news, credential media like the online reports by the independent rating agencies in Malaysia. They focused more towards the supposed allocations which produced both favourable and unfavourable deviations between actual and expected targets. The favourable deviations were documented to tap the performance revenue, capital adequacy, liquidity and total deposit facilities for two years. However, it was unfavourable for the total assets growth achievement.

Moreover, it can be concluded that there should be more allocations given to financing type based on the *bai"bithaman ajil* and *bai" al-inah*, for year 2012 and *murabah* concepts as contrary more *tawarruq* based financing in year 2013. The simulated allocations for year 2012 were the same for both simulated and actual allocation. However, it should be noticed that results gathered in the previous section were the outcome of applying values from the balance sheet for years 2012 and 2013. The new focus based on the revised *Shari"ah* scholars and Board"s preferences have not been made explicit at the time of data collection which is a currently famous and highly favoured mode of financing. Additionally, comparisons between results with the current model and other similar multi-objective balance sheet management models in the literature have also been discussed in this chapter. The main findings of this research were consistent to studies reported in Table 5.1. The research stands out compared to other similar works with a model established and customised to the asset liability environment on an Islamic bank in Malaysia. This model is validated using financial information from BIMB. The model improvises other models in the literature to include religious concerns that can be a benchmark for the academic and research community.

Moreover, it is flexible and can be modified and customised for replications and improvements for future research. The multi-objective asset liability management model is proven to be efficient with enhanced processing capabilities. Other value contributions include considerations of non-interest based and *Shari'ah* compliant objectives and constraints to represent an Islamic bank"s operating environment in Malaysia. The findings, contributions and how this is perceived as the originality of the research with comparisons between these findings and the literature are presented in Table 5.2.

Based on ontological perspective future research directions are discussed in this chapter. Most of the variables of the asset liability management model have been simplified for the computing purpose and this approach is vital to maintain computational controllability. Nevertheless, it should be noted that future researches should be conducted to reflect the best possible scenarios of the asset liability management setting. This can be achieved by conducting series of repeated interviews and working closely with the asset and liability committee or ALCO. The major limitation faced by the author in obtaining support from the time constrained managers has led to few other reasonable and sufficiently valid options for the model"s input such as using static and deterministic single period data from the bank"s financial reports. Future researches should undertake similar studies with greater concerns placed on data availability. For better accuracy, potential researches of this area should consider the different timing of cash flows (or resources) so that the effects of resource allocation within differing scenarios can be addressed. Moreover, one can accomplish the more robust methodology to the optimisation model validation using results generated by neural network. Conclusively this chapter has been shed light on the theoretical and conceptual contributions of this research along with limitations and future research directions.

5.5 General Conclusion

This chapter covers discussions on major findings and comparisons between current and similar models in the literature for delimitations to the current model, gaps to be considered by future researches, challenges (limitations) faced during research, a summary of this research. The scope of this research was clearly defined too. Sciences and research philosophies justifying the conduct, methodologies and sample for the multi-objective asset liability objective optimisation model is included throughout this manuscript. This concept of this research dates back to the contribution by Markowitz (1952) who initiated the portfolio diversification technique for an optimised performance. Later, this field emerged to incorporate multi-objective perspectives in problem solving instead of solving one either the maxima or minima problems. One of the benefits using the optimisation model is that it can be modified to suit either religious or non-religious objectives of the two different types of conventional banks; namely the Islamic and the traditional interest-based bank.

The current asset liability management model reflects the necessary conditions within the asset and liability portfolio of the Malaysian Islamic bank, BIMB. Previous models have all been primarily conventional and, to the knowledge of this researcher, none has sought to tackle the problem of asset liability management for a *Shari'ah*-compliant institution using an optimisation technique that flexibly models different environmental changes.

In short, it gives the privilege to study a vague area of the literature which would bring benefits in terms of knowledge academically and to practitioners from the Islamic banking industry. It is therefore the main objective of the research to look at possible asset liability management models appropriate for the Islamic banking industry. First, it highlights the important factors that influence the effectiveness of asset liability management in Islamic banks in Malaysia. It then seeks to manage these factors through a computer-simulated environment using MATLAB R2012b. Second, it expands the basic economic value added optimisation function to include elements that take account of the provision of capital under *mudaraba* in an Islamic bank. Third, our model is developed to capture the specific characteristics of Malaysian Islamic banking scenarios, including both their micro- and macro-components. As a result of this careful tailoring, our model should provide solutions that are uniquely adapted to the banks in question.

The findings of this research are aimed at assisting both tactical and strategic planning decisions in the Islamic bank studied. At the tactical level, our research should help suggest an ideal portfolio allocation and, consequently, cash flow and asset management; while at the strategic level, the model will provide criteria for longer-term – say five-yearly – performance monitoring to maintain an optimum asset mix. Finally, our suggested model should encourage the research community into further thinking for ways to improve and upgrade the current basic models so that they target effectively the problems surrounding asset and liability management in Islamic banks.

At the same time, the research is inevitably unable to capture all possible constraining factors affecting asset and liability management in the Islamic banking industry. As Mulvey *et al.* (2007) documents that assets and liability models should first resolve hurdles before execution of mathematical models (Mulvey *et al.*, 2007, p. 562), adding that identifying all relevant factors is not easy due to certain practical and data availability issues. Banks do however operate in a highly regulated environment, which means they generally follow a standardised set of rules – rules which researchers can use to formulate constraint functions. Thus, the research flares in a generally acceptable manner to capture sufficiently all necessary features of assets and liability management processes by Islamic banks. In future, researchers may promote the model by focusing on constraints by promoting new financial products and services approved by *Shari'ah* scholars, such as more investments in *ijara, tawarruq* or *istisna* products or channelling fewer funds to investments that may not fully reflect Islamic principles (Abu Hassan, 2009; Chong and Liu, 2009; Gruening and Iqbal, 2008). There were literatures debating about the soundness of *Shari'ah* compliance of some financial products offered by the Islamic bank. An example to this is the *murabahah* based financial product which is said to mirror a "backdoor" to interest-bearing transaction[50].

It was earlier discussed earlier that the Islamic banks operate in a socio-economic environment that is multi-contextual with different beliefs. Malaysia is a country that is of such best example – with multi-cultural social context and highly diverse ethnic groups. Alongside this challenge, the banks have to observe compliance requirements by general regulatory bodies like the World Bank, International Monetary Funds and local banking and financial institution like the central bank. Distinctive math functions were developed for the Islamic bank, in this study for the complete Islamic bank, BIMB, as the benchmark to represent purely religious financial institution in Malaysia. One of it was the non-interest returns generated through investments in various types of *Sharia's* approved assets. Besides, returns were also derived based on the profit-sharing ratio determining the annual rates of returns for various a *mudaraba* assets. Not only were the *mudaraba* based assets were considered in the functions development.

[50] More readings can be obtained from Abu Hassan, 2009; Chong and Liu, 2009; Gruening and Iqbal, 2008 and El Qorchi, 2005

The study accounts for expected costs/ expenses derived as the consequence of managing *mudaraba* and *musharakah* based liabilities to match benefits and expenses arising from the banks normal business operations. Apart from the religious contributions outlined above, the study has also established strategic contributions to charitable organisations. The charitable objective was also included as a constraint function for the bank‟s strategic plans on profit sharing and charitable contributions for the needy. This constraint is important to ensure that the Islamic ethical standards are maintained in this research because it is the duty of every Muslim to abide by the ethical standard which is based on interest free transactions and allocation of resources in the manner to contribute towards betterment for society.

This chapter included discussions and justifications backed by sources from the local news, credential medias like the online reports by the independent rating agencies in Malaysia. Emphasizing the proposed allocations by the model, the favourable and unfavourable deviations between actual and expected targets were generated. The favourable deviations were documented to tap the performance revenue, capital adequacy, liquidity and total deposit facilities for two years. However, it was unfavourable for the total assets growth achievement. Moreover, it can be concluded that there should be more allocations given to financing type based on the *bai"bithaman ajil* and *bai" al-inah*, for year 2012 and *murabah* concepts as contrary more *tawarruq* based financing in year 2013. The simulated allocations for year 2012 were the same for both simulated and actual allocation.

Once again, it should be reminded that results gathered from previous sections were the outcome of applying values from the balance sheet for years 2012 and 2013. The new focus based on the revised *Shari'ah* scholars and Board‟s preferences have not been made explicit at the time data collection. These preferences are popularised among the different schools of thoughts in Islamic teachings and it determines the preferred modes of financing. In practice, the bank favours fixed-return models such as *ijara* and *mudaraba*. The *Shari"ah* model however, prefers financing models which is able to provide sufficient benefits to the bank and the customers such as the *mudaraba* and *musharakah* through the „profit-sharing"based financing model.

Comparisons were also made between results obtained by multi-objective models and other similar models in the literature. Discussions for observed deviations between results documented in this thesis and the literature were covered earlier, in this chapter. Finally, the main findings of the current study were summarised in Table 5.1 and Table 5.2, based on ontological reasoning for clearer paths to future researches. Potential directions for researchers concluded this section. In order to provide flexibility in readopting and customising the thesis" model, the main asset and liability variables have been simplified for the use of the computing and programming processes. This is aimed at maintaining all computational tractability to avoid system collapse and never ending „trapped" loops during the model"s convergence. Nevertheless, future researches are advised to conduct their experiments based on the financial institutions operational context and to adjust their models so that it reflect s all possible scenarios of tests representing practical aspects of the asset liability settings.

One of the suggested ways to achieve this is by conducting series of repeated interviews and working closely with the asset and liability committees or ALCOs. The author faced several limitations during data collection. Among these, one of the major ones was the difficulty faced when obtaining support for stochastic returns and probabilities (or likelihood) of expected percentage changes in investment assets values during different market conditions for the dynamic model and its application. It is believed that the lack of cooperation was due to time constraints by the treasurers, and asset liability executives. Given this limitation, the research resorted to an alternative sufficiently reasonable and yet acceptable input types like the static or deterministic single period data from the bank‟s financial report which was also taken by these two famous authors, Kosmidou and Zopounidis (2004) under their linear programming with goal functions approach to bank‟s balance sheet optimisation. The study develops such model by incorporating all necessary elements of the deterministic features and into the multi-objective optimisation model, as discussed in Chapter 4 of this manuscript.

Future researchers performing similar studies should take precautions when selecting the right model. Greater emphasis should be placed on data availability. Improved data accuracy and precision can be obtained by incorporating analysis and constraints on the timing of different cash flows (the projected cash inflow and outflows), or items contributing to the total value of the bank‟s assets and liabilities), so that these fluctuations are captured and analysed by the model to provide more reliable and practical results on optimized asset liability allocation. Moreover, one could also accomplish better precision through results validation performed using the neural concepts to train processing efficiency and to enhance the model‟s convergence rate.

In summary, the research sheds light for the theoretical and conceptual foundation for future researches of this field. In order to improvise future models, the limitations addressed by this research should be accounted. Key areas of these limitations are suggested in potential delimitations for the model‟s replication and improvements by interested researches in future.

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In summary, the chapter shed light for the theoretical and conceptual foundation for researches alike in the field, along with limitations for potential delimitations by interested researches in the future.

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