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An AHP-based Mutual Fund Portfolio Selection Model

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ABSTRACT

One of the important areas of research in finance is mutual fund portfolio selection. In this paper we present a model which can be used to help decision makers select a suitable mutual fund portfolio based on Analytic Hierarchy Process (AHP) that allows both the investors unique preference structure and their options to be taken into account. The model is set up according to the specialty of the Malaysian mutual fund market which includes attributes unique to a Malaysian investor such as preference in Islamic funds and the option to use the Employees Provident Fund savings as an additional source of investment. The model presented here recommends asset allocation and identifies the most suitable mutual funds within an asset class, consistent with the needs of the investors. This model is utilized to conduct an empirical analysis to select mutual funds offered by Public Mutual Ltd. for five prospective investors. The results indicate that investors should hold diversified portfolios of asset classes with the weights for each asset class adjusted to reflect one's attributes and preferences. The model can help financial advisor to serve prospective investors better and will significantly improve the professionalism in the mutual fund industry.

INTRODUCTION

Portfolio investment in mutual fund has become a very common investment instrument and has grown tremendously in the world economies over the last decade. According to statistics from the International Investment Funds Association (IIFA), there were well over 54,000 funds being registered for sale worldwide at the end of 2004, with total assets under management in excess of USD 16 trillion (approximately RM59.2 trillion) (Koh, 2005). In fact, mutual funds are said to be the fastest growing sector of the U.S. financial services industry and the U.S was the largest mutual fund market in the world with assets of USD 7.6 trillion (RM28.12 trillion) as at the end of 2004. Asian countries have also seen an impressive growth of their domestic savings into investment funds across the developing economies.

In Malaysia, by the 1990's, the mutual fund industry had developed to become the largest source of pooled retail funds in the country (Zuraidah, 2005). 1993 saw the setting up the Federation of Malaysian Unit Trust Managers and the Securities Commission to regulate the mutual fund industry. In 1995, Employee' Provident Fund (EPF) contributors were allowed to withdraw a certain percentage of their retirement fund for investments in approved mutual fund management companies. The introduction of Islamic Funds, in 1998, provided Muslims in particular, with an investment option based on Islamic principles where investors are able to invest in a portfolio of "halal" (allowable) stocks that comply with the principles of Syariah (Muslim tenets). These features have helped propel the popularity of mutual funds and its growth rapidly in the recent years (Zuraidah, 2005). As at Dec. 2005, the net asset value of the mutual funds in Malaysia stand at RM43.79 billion.

Today, with the rapid growth of the mutual fund industry and the large number of mutual funds available, choosing the right funds has become a challenge to many investors. Analytical Hierarchy Process (AHP) (Saaty, 1980) has provided a proven, effective means to assist in the decision-making process of asset allocation and mutual fund selection (see Saraoglu, 2002 & Steuer & Na, 2003). The objectives of this paper, firstly is to develop a AHP model that can be utilized to assist in selecting mutual funds that allows both the investors unique preference structure and their options to be taken into account. The model is set up according to the specialty of the Malaysian mutual fund market which includes attributes unique to a Malaysian investor such as preference in Islamic funds and the option to use the Employees Provident Fund (EPF) savings as an additional source of investment. The second objective is to apply the built model in conducting an empirical study to make a selection of suitable funds offered by Public Mutual Ltd. for five prospective investors. We focus on the Public Mutual Ltd. as it is the largest private mutual fund management company in Malaysia.

LITERATURE REVIEW

The analytic hierarchy process (AHP), developed by Thomas Saaty (1988), is a multi-criteria decision making tool for solving complex and unstructured decision problems in which qualitative factors are of prime importance. The problem is structured from the overall goal to the sub-goals and criteria, forming a hierarchical structure. The alternatives to be ranked are based on a set of criteria. AHP requires the decision maker to provide judgments about the relative importance of each criterion using pairwise comparisons and then specify a preference for each decision alternative using each criterion. This results in a prioritized ranking of the decision alternatives based on the overall preferences expressed by the decision maker.

Since its inception in 1988, the AHP technique has been widely studied (see Zahedi, (1986), Saaty and Katz (1994) and Steuer & Na (2003) for surveys and bibliography study). It has been applied to a host of complex decisions in finance including corporate-credit-granting problem (Srinivan & Kim, 1987), determination of an optimal portfolio mix (Khaksari et. al, 1989), assignment of sovereign debt ratings (Johnson et. al, 1990), determination of investor suitability (Bolster et. al, 1995) and the selection of life insurance contract (Puelz, 1991) among other business problems.

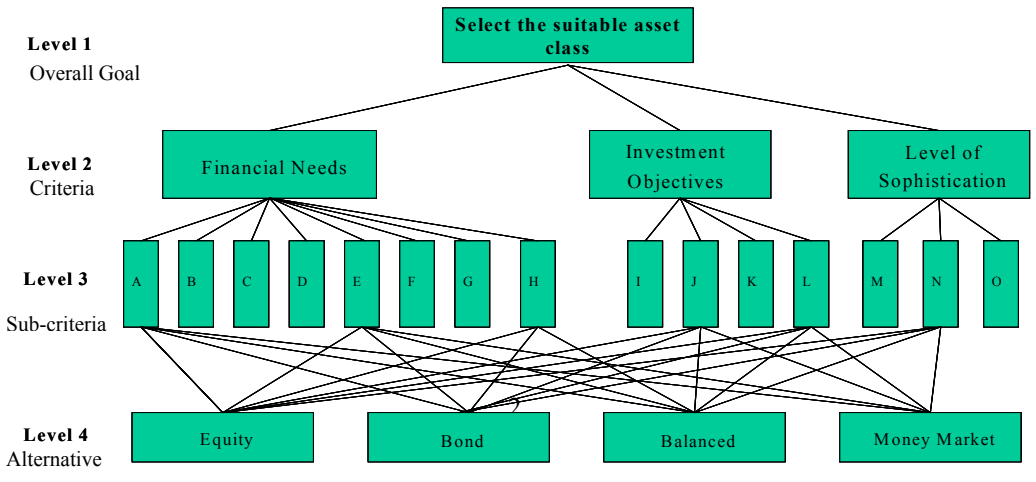
AN AHP BASED MUTUAL FUND PORTFOLIO SELECTION MODEL

In this paper we focus on the portfolio selection of mutual funds offered by Public Mutual Fund Ltd., Malaysia. In developing the AHP model for selecting a suitable mutual fund for a Malaysian investor, we extended the previous AHP models (Saraoglu, 2002 and Bolster, 1995) by including additional selection criteria unique to a Malaysian investor such as preference in Islamic funds and the option to use Employees Provident Fund (EPF) savings as an additional source of investment. The AHP methodology consists of the following four major steps:

Step 1: Develop the hierarchical structure

The AHP begins with the development of a decision hierarchy with an objective, criteria and decision alternatives. A problem can have as many hierarchies and each hierarchy can have as many levels as needed to fully characterize a particular decision situation which may be complex. In our study, the mutual fund selection model is divided into two hierarchies, with four and three levels respectively. The top level of the hierarchy represents the overall objective of the decision process. In the first hierarchy the overall objective is to obtain a suitable set of asset classes from 4 alternatives: equity, bond, balanced and money market mutual funds (Figure 1). The evaluation of a suitable set of asset class requires assessment of a variety of criteria. There are three primary selection criteria that enter into this assessment: financial needs, investment objectives and level of sophistication (Bolster et al., 1995). These three primary criteria comprise the second level of the hierarchy. They are subsequently decomposed into 15 sub-criteria i.e. investor attributes which make up the third level (see Figure 1). These attributes are selected after considering numerous sources as well as empirical research on mutual fund. In Malaysia, an additional source for investment is the retirement fund called EPF. Investors a huge savings in their EPF savings are usually keener to use this money for investment rather than their personal savings. This contributes to the liquid net worth and is considered in this study. Each investor attributes is related to four asset classes i.e. Equity Funds, Balanced Funds, Bond Funds and Money Market Funds forming the final level.

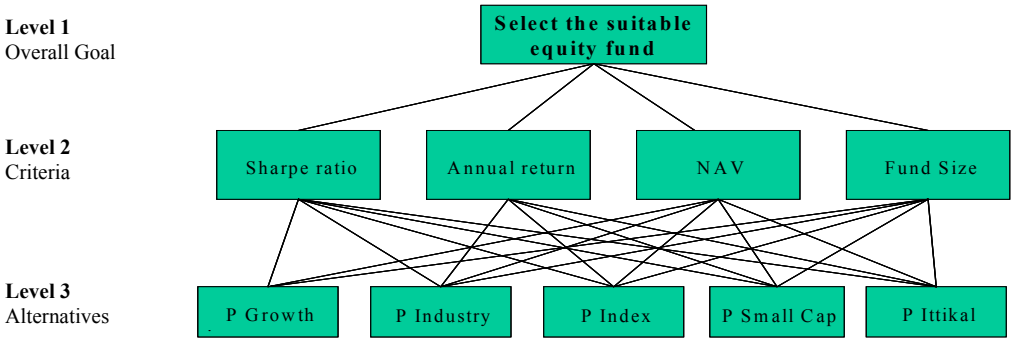
Figure 1: Decision Hierarchy 1 for Public Mutual Fund Selection



A-age, B-Marital Status, C-Total dependents, D-Occupation, E-Annual Income, F-Liquid Net Worth, G-Level of insurance, H-Health I-Risk Tolerance, J-Level of Expected Return, K-Time Horizon, L-Liquidity, M- Investment experience, N-Education and O -Nature of Work.

In the second hierarchy, the overall objective is to select the most suitable mutual funds within each asset class (Figures 2). The figure uses as an example the decision hierarchy for "Equity Funds" class. There are four primary selection criteria in the second level: Sharpe Ratio, Annual Return, Net Asset Value (NAV) and the Size of Fund. These selection criteria are based on structural and operational characteristics of the funds (Saraoglu & Detzler, 2002). These 4 selection criterions are related to the alternative mutual funds offered in each asset class, which is made up of syariah and non-syariah compliant funds.

Figure 2: Decision Hierarchy 2 for Public Mutual Fund Selection (Equity Fund)



Step 2. Assign a relative importance of each selection criterion to the overall goal.

Next, the analyst/expert provide judgments about the relative importance of each criterion and preference amongst the alternatives using pairwise comparison and a 9 point system ranging from 1 (the two options are equally important) to 9 (one option is extremely more important over the other). The 9-point scale has been the standard rating system used for AHP (Saaty, 2000). Using the nine-point scale, pairwise scores are obtained. A complete set of such scores constitutes a pairwise comparison matrix. One such matrix must be generated for each group of criterions or sub-criterions.

For Hierarchy 1, the pairwise comparisons were obtained from empirical research by Bolster et al. (1995) except for the elements in the level of sophistication. We adapt Bolsters pair wise comparison because they are not influenced by varying attributes of the individual investor. However for the level of sophistication criteria an additional element, i.e. nature of work, was introduced in the study and the Public Mutual fund advisor provided the pairwise comparisons. With three criteria under level of sophistication, the fund advisor had to make three pairwise comparisons. For Hierarchy 2, the Public Mutual fund advisor filled out a questionnaire based on the pairwise comparison scale developed by Saaty (1980) and the relative importance of fund selection criteria was determined using the fund advisors responses. With 4 criteria, the fund advisor had to make six pairwise comparisons. The consistency of Fund Advisor's responses was tested using the consistency index and consistency ratio (Saaty, 1980). If inconsistency was observed, the fund advisor was asked to revise his answer until consistency was achieved.

Step 3. Estimate the relative importance weight of each criteria

The relative importance scores obtained next undergo a synthesis process in order to estimate a weight for each criterion. There are different possible methods for synthesizing relative importance scores into weights but we applied a simpler 3-step approach suggested by Anderson et al. (2003) and Moore (2001).

Step 4. Ranking alternatives under each criterion

Once the synthesizing process has been completed for the criteria, it is conducted for the decision alternatives. At the final level of the hierarchy, each decision alternative is considered with respect to a single sub-criterion of the previous level. For example, the decision alternatives for the first hierarchy of our mutual fund selection model are the asset classes. For the ranking of the suitability of assets, the fund advisor filled out the questionnaire based on pairwise comparison to determine the relative importance of each asset class with respect to each attribute specific to an individual investor.

Step 4. Rank each alternative's contribution to the overall goal.

Once the pairwise comparison matrix, which ranks the alternatives in relation to the overall goal, is obtained, the information is synthesized to achieve an overall weight according to the principle of synthesis of weights. Because the final level of the matrix represents the alternatives being compared, global weights for the final level reflect the decision maker's relative weights for the alternatives.

EMPIRICAL ANALYSIS

In this study, we have 5 prospective investors of various background and financial standing. We apply our AHP model to select suitable mutual funds for each investor. Investor A is not married and works as mechanical engineer. Investor B aged 37, who is a married, has two school going daughters. Investor C is middle-aged, in his late fifties with two children, both in college. Investor D is retired with one son who has just started working and his wife is a pre-school teacher. Investor E is a middle aged Muslim, in his mid forties with five school going children. He is a medical consultant with his own private practice. The attributes of each prospective investor are used in the AHP model to determine the ranking of criteria in Hierarchy 1 for asset allocation. The summary of the investor's attributes is tabulated in Table 1.

Table 1: Attributes of the five prospective investors

Investor Attributes [1]	**Investor A**	**Investor B**	**Investor C**	**Investor D**	**Investor E**
Annual income (RM)	100 000	130 000	170 000	36 000	300 000
Liquid net worth (RM)	1.5 mil	10 000	500 000	5 000	100 000
Age	35	37	Late fifties	Late fifties	Mid forties
Total dependants	1	4 (2 children)	4 (2 children)	2	7 (5 children)
Marital status	Single	Married	Married	Married	Married
Level of insurance	Low	High	High	Average	High
Health	Very Good	Very Good	Husband has backache	Husband had heart attack	Good
Occupation	Engineer	Systems analyst and Businessman	Lecturer and housewife	Retired and Pre-school teacher	Medical consultant and housewife
Risk tolerance	High	Above average	Low	Low	Average
Time horizon	10 years	10 years	3 years	1 year	5
Expected return	High	Above average	Average	Average	Average
Liquidity	Low	Moderate	High	Low	High
Investment experience	None	High	Average	None	None
Education	Tertiary	Tertiary and Secondary school	Post-graduate and tertiary	Secondary school	Both Post-graduate
Nature of work	Non-Finance	Finance	Non-Finance	Finance	Non-finance
Other relevant information					
Major income source	Salary and bonus	Wages and profit	Wages	Pension	Consulting
Credit	Debt free	2 cars, house	2 cars	Debt free	2 cars and house

Note 1: 15 Attributes used for hierarchy 1 to determine suitability of asset classes

We used Excel in this study to implement the AHP model developed and to analyze the investor data (Moore, 2001 & Anderson, 2003). The utilization of Excel for the model development is relatively much cheaper than using a software like Expert Choice.

Ranking of Criteria and Sub-Criteria in Hierarchy 1

The pairwise comparisons, local and global weights for the 15 attributes of Hierarchy 1 are shown in Table 2, which is applicable to all 5 prospective investors. The pairwise comparisons show that financial need is ranked as the most important criteria in level 2, followed by investment objectives and level of sophistication. Financial needs relate primarily to annual income and liquid net worth which are tied for importance. Investment objectives related primarily to risk tolerance and investment experience is considered the most important in level of sophistication. The local weights add to 1 for any group of cub-criteria. The global weights are derived from the local weights. For example, because annual income is a sub-element of financial need, which has a local weight of 0.274, the global weight of annual income is 0.274 times 0.557, or 0.153.

Table 2: Ranking of Criteria

Key	Criteria	Pairwise Comparison[1]	Local Weights	Global weights[2]
	Financial Needs	***1***	**0.557**	***NA***
A	Annual Income	1	0.274	0.153
B	Liquid net worth	1	0.274	0.153
C	Age	3	0.123	0.069
D	Dependents	3	0.123	0.069
E	Marital Status	5	0.051	0.028
F	Level of Insurance	7	0.026	0.014
G	Health	4	0.079	0.044
H	Occupation	5	0.051	0.028
	Investment Objectives	***2***	**0.320**	***NA***
I	Risk Tolerance	1	0.474	0.152
J	Time horizon	2	0.288	0.092
K	Level of expected return	3	0.178	0.057
L	Liquidity	6	0.060	0.019
	Level of Sophistication	***4***	***0.123***	***NA***
M	Investment experience	1	0.723	0.089
N	Education	5	0.174	0.021
O	Nature of work	6	0.103	0.013

Note 1: Ranking 1 indicates the most important and 9 indicates the least important.
Note 2: The global weights obtained is used for all prospective investors
NA: Not appliccable

Ranking Of Criteria in Hierarchy 2

The ranking of mutual funds within an asset class is shown in the Tables 3 -5 below. The Equity Funds, Balanced Funds, Bond Funds offer multiple funds within their asset class while the Money Market Funds offers only one fund (i.e. Public Ittikal) and therefore there is no decision alternative within this class and is omitted here.

Table 3: Relative-importance weights and Ranking of Equity Funds

		Alternatives' Ranking				
Criteria	***Weights***	**Public Growth**	**Public Industry**	**Public Index**	**Public Small Cap**	**Public Ittikal**
Sharpe Ratio	0.490	0.087	0.041	0.062	0.286	0.525
Annual return	0.305	0.035	0.133	0.052	0.317	0.463
NAV	0.126	0.432	0.281	0.066	0.176	0.046
Fund Size	0.079	0.297	0.045	0.144	0.068	0.446
Overall Weights		**0.131**	**0.100**	**0.066**	**0.264**	**0.439**

Table 4: Relative-importance weights and Ranking of Balanced Funds

		Alternatives' Ranking		
Criteria	***Weights***	**PB Balanced**	**Public Balanced**	**Public Islamic Balanced**
Sharpe Ratio	0.490	0.649	0.295	0.057
Annual return	0.305	0.690	0.251	0.059
NAV	0.126	0.099	0.150	0.751
Fund Size	0.079	0.154	0.755	0.092
Overall Weights		**0.553**	**0.299**	**0.148**

Table 5: Relative-importance weights and Ranking of Bond Funds

		Alternatives' Ranking		
Criteria	***Weights***	**Public Bond**	**Public Islamic Bond**	**PB Fixed Income**
Sharpe Ratio	0.490	0.164	0.539	0.297
Annual return	0.305	0.755	0.154	0.092
NAV	0.126	0.539	0.297	0.164
Fund Size	0.079	0.724	0.193	0.083
Overall Weights		**0.436**	**0.364**	**0.201**

The fund selected from each asset class based on the results obtained from Table 3 to 5, is now tabulated in Table 6 for two categories: (a) all funds (non-syariah & syariah compliant) and (b) only syariah compliant funds. This serves as a guide for the fund advisor and the prospective investor. The funds selected in row 2 are common for investors that are willing to invest in all types of mutual funds (e.g. Investor A to D). The funds selected in row 3 are common for investors that wish to invest only in Islamic mutual funds (e.g. Investor E).

Table 6: Fund Selected for each Asset Class (Non-Syariah and Syariah)

Asset Class	Equity Funds	Balanced Funds	Bond Funds	Money Market Funds[1]
All funds	Public Ittikal	Public PB Balanced	Public Bond	Money Market
Syariah Only Fund Selected	Public Ittikal	Public Islamic Balanced	Public Islamic Bond	None available

Note 1: Since Money Market Funds is not Syariah compliant, this asset class will not be considered as an alternative decision making for asset allocation.

When Islamic funds are to be considered, the fourth axiom introduced by Saaty (Forman, 2001) comes into play i.e. "individual who have reasons for their beliefs should make sure that their ideas are adequately represented for the outcome to match their expectations". Since the investor is only interested in Syariah compliant funds, the Islamic fund is selected within the asset classes even though the weighting for the Islamic fund may be lower compared to other funds. Hence, in the Balanced Fund asset class, although Public Islamic Balanced has a weight of only 0.148, it is chosen over the other 2 mutual funds in that asset class. Likewise for the Bond Fund asset class, Public Islamic Bond is chosen over Public Bond although its weight is only 0.364.

RESULTS

Selecting Mutual Funds for Investor A

Table 8 shows the initial ranking of suitable asset for the prospective investor A with respect to each sub-criterion based on his attributes. The final overall weight for the four categories of asset class specific to Investor A is tabulated in Table 9.

Investor A has no dependants, has a high-risk tolerance and expects high returns. The final overall weight ranking for Investor A therefore suggests that he should invest more in the high risk, high returns asset class, i.e. in Equity Funds (45%) and Balanced Fund (28%) namely Public Ittikal and Public PB Balanced. The low risk Bond Fund (18%) and Money Market (9%) do not feature prominently in Investor A's portfolio selection.

Table 8: Suitability rankings of individual asset allocation based on Investor A's Attributes

Investor Attributes	Global weights	Equity Funds	Balanced Funds	Bond Funds	Money Market Funds
Income	0.153	1	3	4	7
Liquid net worth	0.153	1	2	3	5
Age	0.069	1	2	4	8
Dependents	0.069	1	2	4	6
Marital Status	0.028	1	1	5	7
Insurance	0.014	9	4	1	1
Health	0.044	1	3	4	7
Occupation	0.028	1	3	4	7
Risk Tolerance	0.152	1	2	6	7
Time horizon	0.092	1	2	3	6
Expected return	0.057	1	2	6	7
Liquidity	0.019	1	1	6	7
Investment experience	0.089	7	4	1	2
Education	0.021	1	2	2	4
Nature of work	0.013	5	3	1	1

Note 1: Ranking 1 indicates the most suitable asset and 9 indicates the least suitable asset.

Table 9: Individual Asset Allocation Based on Investor A's Attributes

Investor Attributes	Global weight	Equity Funds	Balanced Funds	Bond Funds	Money Market Funds
Income	0.153	0.545	0.244	0.156	0.055
Liquid net worth	0.153	0.471	0.284	0.171	0.074
Age	0.069	0.494	0.313	0.147	0.045
Dependents	0.069	0.497	0.313	0.121	0.068
Marital Status	0.028	0.421	0.421	0.106	0.052
Insurance	0.014	0.042	0.134	0.397	0.427
Health	0.044	0.545	0.244	0.156	0.055
Occupation	0.028	0.545	0.244	0.156	0.055
Risk Tolerance	0.152	0.516	0.337	0.089	0.058
Time horizon	0.092	0.474	0.288	0.178	0.060
Expected return	0.057	0.516	0.337	0.089	0.058
Liquidity	0.019	0.431	0.431	0.084	0.055
Investment experience	0.089	0.055	0.131	0.498	0.316
Education	0.021	0.433	0.239	0.239	0.089
Nature of work	0.013	0.069	0.153	0.389	0.389
Overall Weights		**0.450**	**0.279**	**0.179**	**0.092**

Selecting Mutual Funds for the Other Investors

Similar ranking and calculations were carried out for the other four prospective investors and the results are tabulated in Table 10. Table 10 summarizes the suitable asset allocation percentages for each of the different asset class considered as determined in Hierarchy 1. The mutual fund selected for individual investors for each of the asset class category is determined in Hierarchy 2.

Table 10: Summary of Portfolio Selection Using the AHP Model

Investor	Asset Class Category	Percentage[1]	Fund Selected[2]
A (Single, Engineer)	Equity	45.0	Public Ittikal
	Balanced	27.9	Public PB Balanced
	Bond	17.9	Public Bond
	Money Market	9.2	Money Market
B (Married, Businessman)	Equity	35.3	Public Ittikal
	Balanced	31.9	Public PB Balanced
	Bond	19.0	Public Bond
	Money Market	13.8	Money Market
C (Married, University Lecturer)	Equity	22.3	Public Ittikal
	Balanced	18.9	Public PB Balanced
	Bond	30.6	Public Bond
	Money Market	28.2	Money Market
D (Married, Retired)	Equity	9.7	Public Ittikal
	Balanced	13.4	Public PB Balanced
	Bond	33.4	Public Bond
	Money Market	43.6	Money Market
E (Married, Medical consultant, Preferred Islamic Funds only)	Equity	26.0	Public Ittikal
	Balanced	31.0	Public IslamicBalanced
	Bond	43.0	Public Islamic Bond

DISCUSSION

The overall goal of the AHP model developed in this study is to compose a suitable investment portfolio for individual investors. With a high degree of consistency through a series of pairwise comparisons, this model produces a distribution of the percentages of the various kinds of mutual funds to be held in the portfolios of different kinds of investors. In this study, the AHP model from literature has been extended by including additional attributes unique to a Malaysian investor, namely the option to use the Employees' Provident Fund (EPF) savings as an additional resource for investment. Hence, the liquid net worth of the Malaysian investor increases with his EPF savings included. The model built in this study is also different from the ones reported in literature because of the inclusion of the investor's preference for Islamic funds. Therefore, this model takes into consideration the fourth

axiom introduced by Saaty when assigning the final weights to the alternatives. The asset allocation for Investor E (a Muslim investor) is an example of how the fourth axiom comes into play in the AHP model. Money market Funds are not even considered as an alternative asset class in Hierarchy 1, Level 4 for Investor E because Money Market Funds are not Syariah compliant. Calculations made show that Investor E's investment profile has a larger percentage (43%) towards the low risk Bond Funds as compared to the higher risk Equity Funds and Balanced Funds (refer to Table 10). We see further that although PB Balanced has a much higher overall weight of 0.553 in the Balanced Fund asset class, Investor E is recommended the Public Islamic Balanced Fund, which has a much lower overall weight i.e. 0.148 (refer to Table 4) because this fund is Syariah compliant. Once again, the fourth axiom is applied when coming to this conclusion. Likewise, although Public Bond is the preferred fund in the Bond Fund asset class with an overall weight of 0.436, Investor E is recommended the Public Islamic Bond, which has an overall weight of 0.364, which is lower than Public Bond. The results indicate that all investors should hold diversified portfolios of asset classes with the weights for each asset class adjusted to reflect one's attributes and preferences.

CONCLUSION

The AHP model developed in this study helps the fund advisor to select mutual funds by taking into account unique preferences and options of an individual investor. There are several advantages of the built model. Firstly, the quantitative model developed makes the process of choosing funds less subjective and ensure consistency. Secondly, the AHP analysis helps both the fund advisor and the investor to gain a better understanding of the trade-offs in the decision making process and a clear assessment of why the particular fund in recommended. Finally, the model built with Excel in this study is cost effective and user-friendly yet rigorous enough to solve the complex decision problem of mutual fund selection. The model can help financial advisor to serve prospective investors better and will significantly improve the professionalism in the mutual fund industry.

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