Multi-Choice Goal Programming Model for Optimal Financial Resources in Islamic Bank

(Model Pengaturcaraan Gol Pelbagai Pilihan bagi Sumber Kewangan yang Optimal di Bank Islam)

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ABSTRACT

As the primary operational tool in the Islamic economics system, Islamic banking is assumed to run on the broader perspective of multi-dimensional objectives based on the foundation of shariah principles. This paper explicitly develops a multi-choice goal programming (MCGP) model of an Islamic bank for the optimal allocations of financial resources that satisfy both economic and social goals. The optimization model is verified using data from one of the premier Islamic banks in Malaysia as a sample model in determining the patterns and strategies taken in the allocations of financial resources. The veracity of the model is tested in terms of its ability to meet the specified target goals with minimum total deviations and to project the optimum allocation of asset and liability composition for a one-year time horizon. Results showed that the model could generate optimal financial resources that meet the specified target goals for economic and social objectives. A simulation analysis has been successfully performed to see the impact of changing the priority weight of management goals on the composition of financial resources. Thus, the model would be beneficial to the policymakers at Islamic banks for decision support and planning in view of its ability to incorporate economic and social objectives. Additionally, the proposed MCGP model offers flexibility to decision-makers in setting management target goals in the form of interval values to avoid error estimation of the decision.

Keywords: Multi-choice goal programming; optimization; Islamic bank; economic objectives; social objectives.

ABSTRAK

Sebagai alat operasi utama dalam sistem ekonomi Islam, perbankan Islam dianggap beroperasi berdasarkan perspektif objektif multi-dimensi yang lebih luas berdasarkan asas prinsip-prinsip syariah. Makalah ini secara khusus membangunkan model pengaturcaraan gol pelbagai pilihan (MCGP) bagi bank Islam untuk peruntukan sumber kewangan yang optimum dalam memenuhi objektif ekonomi dan sosial. Model pengoptimuman ini telah menggunakan data dari salah satu bank Islam utama di Malaysia sebagai model contoh dalam menentukan corak dan strategi yang diambil di dalam peruntukan sumber kewangan. Ketepatan model ini diuji dari segi kemampuannya untuk memenuhi sasaran objektif yang ditentukan dengan jumlah sisihan minimum dan untuk mensasarkan peruntukan aset dan liabiliti optimum bagi jangka masa satu tahun. Hasil kajian menunjukkan bahawa model yang dibangunkan dapat mempamerkan sumber kewangan optimum yang memenuhi sasaran matlamat yang ditentukan bagi objektif ekonomi dan sosial. Analisis simulasi juga berjaya dijalankan untuk melihat impak perubahan pemberat keutamaan bagi sasaran matlamat pengurusan terhadap komposisi sumber kewangan. Oleh itu, model ini dilihat boleh memberi manfaat kepada pembuat dasar di bank Islam sebagai sokongan keputusan dan perancangan memandangkan kemampuan model ini dalam menggabungkan objektif ekonomi dan sosial. Selain itu, model MCGP yang dicadangkan ini juga menawarkan fleksibiliti kepada pembuat keputusan untuk menetapkan sasaran matlamat pengurusan di dalam bentuk nilai selang bagi mengelakkan daripada penganggaran ralat di dalam keputusan.

Kata kunci: Pengaturcaraan gol pelbagai pilihan, pengoptimuman, bank Islam, objektif ekonomi; objektif sosial.

INTRODUCTION

The prominence of Islamic banking as the primary operational tool in the Islamic economic system heavily depends on the efficient integration of economic and social objectives (also referred to as socio-economic objective) in promoting social justice and fairness derived from the *Maqasid Shariah* principle (Chapra 1985; Siddiqui 2002). This objective falls beyond the conventional value of a neutral capitalist system that builds on a doctrine of satisfying self-interest, which gives more focus on profit maximization. In fact, numerous studies by renowned Islamic scholars, such as Al-Jarhi (2017), Asutay & Harningtyas (2015) Haron (1995), and Naqvi (2016), opined that ethical, equitable, and sustainable business dealings were also the key foundation of Islamic banking operations to create an enduring balance between the profit motive and social wellbeing for the betterment of the whole society.

With this in mind, an Islamic bank is believed to have an excellent capacity to become the catalyst for the economic growth of a country through mobilizing financial resources and finding development solutions for potential projects. These could include providing infrastructural supports, contributing to various social programs, empowering micro-enterprise, promoting better education and health, and reducing the vulnerability of the poor (Jan, Ullah & Asutay 2015; Furqani, Khalil & Hamid 2015). The socio-economic objective of Islamic banks also can further increase the financial inclusion within the society in several ways. For instance, Islamic bank can enhance different types of redistributive instruments, such as *Qard al-Hasan* financing and *waqf* funds, to provide a financial solution opportunity for the poor and lower-income groups who do not have access to any microfinancing due to lack of collateral or lack of affordability owing high financing costs. Financial inclusion by Islamic banks also can be increased through supporting partnerships or equity-based financing instead of debt-based financing. The wider the applications of equity-based financing by an Islamic bank, the greater outreach to microenterprises can be achieved with the strong principle of promoting entrepreneurship and value-creating projects (Hudaefi & Noordin 2019; Nouman & Ullah 2014; & Nouman, Ullah & Gul, 2018; Shinkafi & Ali 2017).

From the holistic view, the objective of Islamic banks is therefore embracing a wider perspective of multi-dimensional objectives that integrate the economic goals with social goals derived from the foundation of shariah principles (Ahmadi 2016; Dusuki 2008). Any deviation from these principles could lead to financial resource misallocations and imbalances that may limit or negate the achievement of socio-economic objectives in any Islamic banks as both economic and social objectives are interdependent with each other (Asutay 2012). This implies that setting unreasonably high target goals on economic objectives solely may affect other important social objectives, in which this condition is not desirable. Against this backdrop, the question on the optimal composition on financial resource allocations in Islamic banks is critical, considering target goals and constraints in maximizing both economic and social objectives. The answer to the issue is vital for Islamic banks to counterbalance the multiple objectives on economic aspects with the conception of social obligations and wellbeing for the quest in wealth creation and value creation.

Motivated by the rapid developments of the Islamic banking industry, this paper aims to develop an optimization model for multiple objectives via multi-choice goal programming (MCGP) model. The proposed model is specifically designed for financial resource allocations that should contribute to the realization of the socio-economic objectives for an Islamic bank. The MCGP model portrays that while pursuance of economic objectives is also encouraged in Islam, but the social dimension that matched the Islamic principles on promoting the concept of justice and welfare to the society at large needs to be integrated into the overall objective of Islamic bank. Thus, the allocations of financial resources at an Islamic bank needs a model that can adequately attend to the following issues:

1. The model must be able to accommodate multiple conflicting goals simultaneously that are relevant to the economic and social objectives of an Islamic Bank;
2. The model could provide feasible optimal solutions that satisfy multiple goals and other constraints; and
3. The model must be robust in terms of its ability to minimize total deviations of target goals even with changes applied to parameters involved.

LITERATURE REVIEW

To date, many studies have been developed pertaining to the multi-objective models in the banking field. The majority of the studies on multi-objective banking models were explored through various optimization techniques, which finally shed light on the methodological contribution to the study on the banking field. Earlier studies have acknowledged that the optimization techniques can suitably work as normative tools in the banking industry (e.g., Cohen & Hammer 1967; Eatman & Sealey 1979; Fortson & Dince 1977; Guven & Persentili 1997; Kosmidou & Zopounidis 2004; Zanakis & Gupta 1985). In recent developments on the optimization techniques, some further modifications have been made to allow the fulfilments of many different objectives and managerial decisions required in banking applications and are proven computationally tractable to be applied to large problems in the

banking industry (e.g., Amin, Al-Muharrami & Toloo 2019; Azizi & Neisy 2017; Salas-Molina, Rodriguez-Aguilar & Pla-Santamaria 2020).

In optimization, the goal programming (GP) is an essential technique for decision-makers to solve multi-objective decision-making problems in finding a set of satisfying solutions. It was first introduced by Charnes and Cooper (1961), further developed by many other researchers up to the present. The philosophy of GP methods is to reduce the multiple goals achievement problem into a single objective of minimizing a positive/negative deviation from specific target goals/values. Nevertheless, in most cases, decision-makers prefer to set goals in a range of interval values instead of a single goal value for different management objectives to avoid error estimation of decision making (Chang 2007).

To tackle such an imprecision to the problem mentioned above, Charnes and Collomb (1972) become a pioneer to introduce an interval GP model to relax the limitation on the specific target value from the classical version of GP. In other words, the interval GP allows decision-makers to set an interval target value that is satisfactory for each goal and penalize deviation from either end of this interval target levels. This initiative is further expanded by Jones and Tamiz (1995), who described several methods for interval GP with increasing, decreasing, and non-linear penalty functions. Moreover, Vitoriano and Romero (1999) considered how to avoid the extremely biased results regarding some of the goals in interval GP, while Romero (2004) develops a general achievement function for GP and interval GP.

Chang (2007), on the other hand, derives a concise approach to solve interval GP with increasing and decreasing penalty functions. To represent uncertainty or imprecision aspiration levels problems, Chang (2008) has further proposed a novel formulation GP method, which enables decision-makers to set more aspiration levels by using multi-choice aspiration levels for each management goals. It is called MCGP that fundamentally embraces the concept of 'one goal, mapping multiple aspiration levels.' This proposed method explicitly allows decision-makers to address the decision problems related to the case where 'the more/higher achievement of the aspiration level/target goal the better' and 'the less/lower achievement of the aspiration level/target goal, the better.'

MCGP method formerly requires multiplicative terms of binary variables to express the multi-choice aspiration levels in the GP model, which has led to the difficulty to be implemented and understood by the users (Chang 2007). Thus, Chang (2008) has come out with an alternative method or so called a revised version of MCGP model to provide the efficient use of this method by proposing a linear form of MCGP, which can be solved using common linear programming software packages. With the improvement to the usefulness of MCGP, decision-makers can utilize this method in making better decisions with regards to multiple objectives management problems by setting target goals to be achieved in the form of interval values instead of fixed target goals.

This paper specifically proposes to utilize the MCGP model in developing an Islamic bank model within the context of multiple objectives to achieve the ideal socio-economic objective as inspired by the *Maqasid Shariah*. None of the previous studies have sought to maximize multiple objectives function of Islamic bank that comprises both the economic and social objectives in the context of financial resources allocations (e.g., Abou-El-Sood & El-Ansary 2017; Bedoui & Mansour 2015; Chong et al. 2016; Mohammed 2007; Razaei & Sherafati 2015). The inclusion of the social objectives that seek to cater to the financial needs of multiple stakeholders of Islamic banks is an area that sets this paper different from the previous studies on the optimization of the multi-objective model in banking firms. Additionally, the limitation in getting precise target goals/aspiration levels for the objectives in Islamic banks can lead to error estimation of decision making or unacceptable solutions from the model. Thus, the advantage of the proposed method will allow the decision-makers to set target goals/aspiration levels in the form of interval values suggested by Chang (2008) for MCGP to overcome the problem mentioned above.

DATA AND METHODOLOGY

DATA

The formulation of MCGP for Islamic banks in this study is modelled using data sources from the financial reports of Bank Islam Malaysia Berhad (BIMB). The data is collected to establish the deterministic and stochastic data that span over 2007-2016 to determine the patterns and strategies taken by the Islamic bank in the allocations of financial resources. Some other relevant data or information were also taken into consideration, such as statutory and legislative requirements by the Bank Negara Malaysia (BNM). All the data sources are utilized to assist the specification of the target goals and constraints with the aim to produce optimal financial resources allocations strategies that satisfy both economic and social objectives for a one-year time horizon. BIMB has been chosen for evaluating the performance and viability of the MCGP since the bank was the pioneer in the Islamic financial institution that commenced its operation beginning from 1 July 1983 under the Islamic Banking Act (1983). As the first full-fledged Islamic commercial bank that offers *Shariah*-based products and services, the bank provides

a wide range of deposits, financing and banking products and services comparable to the Malaysian economy irrespective of race, religion, or company.

The model provides an overall formulation to the financial resources allocations strategies based on past data reflecting on the trends of the sample Islamic bank regarding their outlook on setting targets, goals, and constraints. Thus, it should be mentioned that this may not hold the same if this model is applied to other Islamic banks as some formulations may be modified, changed, or relaxed depending on several factors, such as the bank's internal policies, directions, and objectives setting, and different strategies on financial resources management or asset-liability management (ALM). The formulation of MCGP model in this paper uses 25 structural decision variables, where eight items correspond to assets (A_i), seven items correspond to liabilities and equities (L_j), and ten rigid items are from income statement or profit /loss account (PL_L), as presented in TABLE 1.

TABLE 1. The decision variables of the MCGP formulation

Assets, Liabilities & Equities	Decision variables	Profit/loss account	Decision variables
Cash and cash equivalents	*A1*	Income from financing activities	*PL1*
Interbank placements	*A2*		
Investment in securities	*A3*	Income from other assets	*PL2*
Debt-based financing	*A4*	Other related income	*PL3*
Equity-based financing	*A5*	(Direct expenses)	*PL4*
Statutory deposits with BNM	*A6*	(Income attributable to non-mudharabah depositors)	*PL5*
Fixed assets	*A7*		
Other assets	*A8*	(Income attributable to mudharabah depositors)	*PL6*
Non-*mudharabah* deposits	*L1*		
Mudharabah deposits	*L2*	(Personnel expenses)	*PL7*
Bills and acceptance payable	*L3*	(Other operating expenses)	*PL8*
Other liabilities	*L4*	(Zakat)	*PL9*
Share capital	*L5*	(Distributable profit to shareholders)	*PL10*
Other reserves	*L6*		
Retained earnings	*L7*		

METHODOLOGY

In the classical form, GP lets decision-makers to fix their aspiration levels for each target goal. The main objective of GP is to minimize the undesirable deviations between the achievement of goals and the aspiration levels. Based on the basic GP, this study utilizes MCGP methodology proposed by Chang (2008), which had different attitudes by optimizing the objective function following the concept of 'one goal, mapping multiple aspiration levels.' The proposed method specifically allows decision-makers to address the decision problems which relate to the case of 'the more/higher achievement of the aspiration level/target goal the better' and 'the less/lower achievement of the aspiration level/target goal the better.' Based on Chang (2008), the MCGP-achievement functions can be formulated with auxiliary constraints and additional variables into two types of the decision on target goals: *'the more, the better'* and *'the less, the better'*.

First type of decision on target goal – *'the more, the better'*

Achievement function:

$$\text{Minimize } Z = \sum_{i\in m}(d_i^+ + d_i^-) + (e_i^+ + e_i^-) \quad (1)$$

Goals and constraints:

$$\textit{subject to}\ (\text{s.t.})\ \sum_{j=1}^{n} a_{ij}x_j - d_i^+ + d_i^- = \mathrm{G}_i, \text{ for } i = 1,\ldots,m \quad (2)$$

$$\mathrm{G}_i - e_i^+ + e_i^- = G_{i,max}\ , \text{ for } i = 1,\ldots,m \quad (3)$$

$$G_{i,min} \le G_i \le G_{i,max}, \quad (4)$$

$$d_i^+, d_i^-, e_i^+, e_i^-, x_j \ge 0, \text{ for } i = 1,\ldots,m; j = 1,\ldots,n \quad (5)$$

Second type of decision on target goal – *'the less, the better'*

Achievement function:

$$\text{Minimize } Z = \sum_{i\in m}(d_i^+ + d_i^-) + (e_i^+ + e_i^-) \quad (6)$$

Goals and constraints:

$$\textit{subject to}\ (\text{s.t.})\ \sum_{j=1}^{n} a_{ij}x_j - d_i^+ + d_i^- = G_i, \text{ for } i = 1,\ldots,m \quad (7)$$

$$G_i - e_i^+ + e_i^- = G_{i,min}\text{ , for } i = 1,\ldots,m \quad (8)$$
$$G_{i,min} \leq G_i \leq G_{i,max}, \quad (9)$$
$$d_i^+, d_i^-, e_i^+, e_i^-, x_j \geq 0, \text{ for } i = 1,\ldots,m; j = 1,\ldots,n \quad (10)$$

where d_i^+ and d_i^- are positive and negative deviations attached to $|a_{ij}x_j - G_i|$, respectively, while $e_i^+$and e_i^- represent positive and negative deviations for $|G_i - G_{i,max}|$ and $|G_i - G_{i,min}|$, respectively. The upper and lower bound for the *i*th aspiration levels are represented by $(G_{i,\max})$ and $(G_{i,min})$, respectively. G_i is introduced as a continuous variable with a range of interval values, where $G_{i,min} \leq G_i \leq G_{i,max}$, while x_j and a_{ij} are the decision variables and parameters, respectively.

FORMULATION FOR GOAL CONSTRAINTS

The formulation to maximize the economic profit of Islamic bank as in (11) is measured through the economic value added (EVA) performance following Bidabad and Allahyarifard (2019) as well as Muda and Ismail (2011), where the target goal for the year 2016 is set at 3.55% above the previous year's EVA. *TEP* is the value for the target economic profit set for this goal. At the same time, the cost of capital of 3.32% is represented by the average of 6-months Kuala Lumpur interbank offer rate (KLIBOR), as the indicative or benchmark rate.

G1 – Maximize economic profit
Achievement function: *minimize* $(d_1^+ + d_1^-)$

$$(PL_1 + PL_2 + PL_3 - PL_4 - PL_5 - PL_6 - PL_7 - PL_8 - PL_9 + PL_6) - 0.0332 \times (L_2 + L_5 + L_6 + PL_1 + PL_2 + PL_3 - PL_4 - PL_5 - PL_6 - PL_7 - PL_8 - PL_9 - PL_{10}) - d_1^+ + d_1^- = 3.55 \times TEP \quad (11)$$

The MCGP formula for liquidity goal, as expressed in (12), is defined as the percentage of liquid assets over total assets held by the bank, following Muda and Ismail (2011). The range target goal of 20% to 50% *(the more, the better)*, as in equations (13) and (14) is assumed for the liquidity goal in this paper is in line with the guidelines of the Central Bank under the Basel III ruling for Malaysian banks to reach higher liquidity ratio by the year 2019. The upper bound of 50% that is set in (13) is to precisely capture for 'the more, the better' case, which indicates that the higher achievement of this goal is preferable.

G2 – Maintain sufficient cashflows
Achievement function: *minimize* (d_2^-)
The goal that relates to liquidity is expressed as follows:

$$A_1 + A_2 + A_3 - G_2 \times (A_1 + A_2 + A_3 + A_4 + A_5 + A_6 + A_7 + A_8) - d_2^+ + d_2^- = 0, \quad (12)$$
$$G_2 - e_2^+ + e_2^- = 50\%\text{ , for } |G_2 - 50\%|, \quad (13)$$
$$20\% \leq G_2 \leq 50\%, \text{ for bound of } G_2. \quad (14)$$

Based on the international guidelines, the Islamic bank is required to maintain a minimum of 8% of capital ratio, as shown in equation (15), following the minimum requirement recommended by the Basel Committee on Banking Supervision.

G3 – Managing capital
Achievement function: *minimize* (d_3^-)

$$(L_5 + L_6 + PL_1 + PL_2 + PL_3 - PL_4 - PL_5 - PL_6 - PL_7 - PL_8 - PL_9 - PL_{10}) - 0.08 \times (A_1 + A_2 + A_3 + A_4 + A_5 + A_6 + A_7 + A_8) - d_3^+ + d_3^- = 0 \quad (15)$$

By adopting from Asutay and Harningtyas (2015), Jaffar and Manarvi (2011), and Rosly and Mohd. Zaini (2008), the measurement for the fair return to shareholders as in (16) is defined as net profit after tax and zakat as a percentage of bank's total equity, which indicates the net earnings to shareholders per dollar of the Islamic bank's equity capital. The range target goal is set equal to 13% - 30% (*the more, the better*), based on the forecasted trend of historical data.

G4 – Fair return to shareholders
Achievement function: *minimize* (d_4^-)

$$(PL_1 + PL_2 + PL_3 - PL_4 - PL_5 - PL_6 - PL_7 - PL_8 - PL_9) - G_4 \times (L_5 + L_6 + PL_1 + PL_2 + PL_3 - PL_4 - PL_5 - PL_6 - PL_7 - PL_8 - PL_9 - PL_{10}) - d_4^+ + d_4^- = 0, \quad (16)$$
$$G_4 - e_4^+ + e_4^- = 30\%, \text{ for } |G_4 - 30\%|, \quad (17)$$
$$13\% \leq G_4 \leq 30\%, \text{ for bound of } G_4. \quad (18)$$

Goal (G5) in equation (19) is defined as income attributable to depositors to total deposits on both *mudarabah* and non-*mudharabah* accounts. It reveals how well the Islamic bank could generate sensible profits or returns to the depositors in an effort to compensate for the contribution from the depositors for deposit funds. It is set to be within a range of target value 2% to 4% (*the more, the better*), as in (20) and (21), referring to the past data trend in the financial statement of the Islamic bank.

G5 – Fair return to depositors
Achievement function: *minimize* (d_5^-)

$$PL_5 + PL_6 - G_5 \times (L_1 + L_2) - d_5^+ + d_5^- = 0\ , \quad (19)$$

$$G_5 - e_5^+ + e_5^- = 4\%, \text{ for } |G_5 - 4\%|, \quad (20)$$

$$2\% \ \leq \ G_5 \leq 4\%, \text{ for bound of } G_5. \quad (21)$$

The goal of fairness and justice (G6) also applies to the employees or human resources perceived as one of the critical contributing factors for the success of an Islamic bank. As expressed in equation (22), the goal constraint is assumed to be stable at 31% based on the average performance of the historical data from the year 2007 until 2016.

G6 – Fair benefits to employees
Achievement function: *minimize* ($d_6^+ + d_6^-$)

$$PL_7 - 0.31 \times (PL_1 + PL_2 + PL_3 - PL_4 - PL_5 - PL_6 - PL_7 - PL_8 - PL_9) - d_6^+ + d_6^- = 0. \quad (22)$$

Goal (G7) is essential since the concept of PLS is prescribed to the spirit of Islamic banking establishment in upholding justice and eliminate oppression among society. By sharing any profit and loss incurred, it will drive fairness that eventually creates value for each contracting party involved *(*Abdul Rahman & Mohd Nor 2016). Although the figure is tiny and, in fact, nil towards the recent years of the study, the range of target value assumed for this goal is set around 0.01% to 0.04% (*the more, the better*) as in (24) and (25) from total financing offered.

G7 – Enhance profit and loss sharing (PLS) financing to customers
Achievement function: *minimize* (d_7^-)

$$A_5 - G_7 \times (A_4 + A_5) - d_7^+ + d_7^- = 0, \quad (23)$$

$$G_7 - e_7^+ + e_7^- = 0.04\%, \text{ for } |G_7 - 0.04\%|, \quad (24)$$

$$0.01\% \ \leq \ G_7 \leq 0.04\%, \text{ for bound of } G_7. \quad (25)$$

The range of target value for the goal (G8) is set between 30% to 60%, as in equations (27) and (28), following the historical data trend that always produces a high rate for this ratio. Nevertheless, this measure is set to be (*the less, the better)* case in MCGP formulation with the assumption to limit the dominant use or over dependence of the Islamic bank on debt-based financing.

G8 – Charge reasonable financing costs to customers
Achievement function: *minimize* (d_8^+)

$$PL_1 - G_8 \times (PL_1 + PL_2) - d_8^+ + d_8^- = 0, \quad (26)$$

$$G_8 - e_8^+ + e_8^- = 30\%, \text{ for } |G_8 - 30\%|, \quad (27)$$

$$30\% \ \leq \ G_8 \leq 60\%, \text{ for bound of } G_8. \quad (28)$$

The range of target value for this goal (G9) is set equal to 0.4% to 3% (*the more, the better*), as in equations (30) and (31), with the expectation that the Islamic bank will continue to empower both obligatory alms through zakat payment, as well as voluntary alms through other redistributive instruments, such as *Qard al-hasan* (benevolent) financing and *waqf* (endowment).

G9 – Redistribution of wealth
Achievement function: *minimize* (d_9^-)

$$PL_9 - G_9 \times (L_5 + L_6 + PL_1 + PL_2 + PL_3 - PL_4 - PL_5 - PL_6 - PL_7 - PL_8 - PL_9 - PL_{10})\ d_9^+ + d_9^- = 0, \quad (29)$$

$$G_9 - e_9^+ + e_9^- = 3\%, \text{ for } |G_9 - 3\%|, \quad (30)$$

$$0.4\% \ \leq \ G_9 \leq 3\%, \text{ for bound of } G_9. \quad (31)$$

Social welfare goal (G10) in Islamic banks can be further expanded by enhancing productive investments to develop a systematic economic and value-added economic activity. Thus, this specific objective is set to achieve the target goal equal to 20% to 60% (*the more, the better*), as expressed in (33) and (34).

G10 – Enhanced productive investments

Achievement function: *minimize* (d_{10}^-)

$$L_2 - G_{10} \times (L_1 + L_2) - d_{10}^+ + d_{10}^- = 0, \quad (32)$$

$$G_{10} - e_{10}^+ + e_{10}^- = 60\% \text{ for } |G_{10} - 60\%|, \quad (33)$$

$$20\% \leq G_{10} \leq 60\%, \text{ for bound of } G_{10}. \quad (34)$$

Based on the goals mentioned above, the achievement function of the MCGP problem takes the following form:

$$\textit{Minimize } Z = W_1(d_1^+ + d_1^-) + W_2(d_2^-) + (e_2^+ + e_2^-) + W_3(d_3^-) + W_4(d_4^-) + (e_4^+ + e_4^-) + W_5(d_5^-) + (e_5^+ + e_5^-) + W_6(d_6^+ + d_6^-) + W_7(d_7^-) + (e_7^+ + e_7^-) + W_8(d_8^+) + (e_8^+ + e_8^-) + W_9(d_9^-) + (e_9^+ + e_9^-) + W_{10}(d_{10}^-) + (e_{10}^+ + e_{10}^-) \quad (35)$$

where W_j represents the weight assigned for each goal.

RESULTS AND DISCUSSIONS

RESULTS ON DEVIATIONAL FROM THE DECISION OF MCGP-ACHIEVEMENT ON TARGET GOALS

The results on the deviations of target goals and the decision of MCGP-achievement are presented in TABLE 2.

TABLE 2. Results on the deviations of target goals and the decision of MCGP-achievement

Objectives/ Goals	Target goals in a range of interval values	Goal achievement	Decision of MCGP-achievement on target goals	MCGP model achievement	Deviation from MCGP-achievement on target goals
(1)	(2)	(3)	(4)	(5)	(6)
G1*	-	$d^+, d^- = 0$	N/A	669,516.23	N/A
G2	20% - 50%	$d^- = 0$	The more the better	50%	$e_2^+, e_2^- = 0$
G3*	-	$d^- = 0$	N/A	8%	N/A
G4	13% - 30%	$d^- = 0$	The more the better	14.73%	$e_4^+ = 0$ e_4^- = 15.27%
G5	2% - 4%	$d^- = 0$	The more the better	2.21%	$e_5^+ = 0$ e_5^- = 1.79%
G6*	-	$d^+, d^- = 0$	N/A	31%	N/A
G7	0.01% - 0.04%	$d^- = 0$	The more the better	0.04%	$e_7^+, e_7^- = 0$
G8	30% - 60%	$d^+ = 0$	The less the better	59.09%	$e_8^+ = 29.09\%$ e_8^- = 0
G9	0.4% - 3%	$d^- = 0$	The more the better	0.40%	$e_9^+ = 0$ e_9^- = 2.60%
G10	20% - 60%	$d^- = 0$	The more the better	30.06%	$e_{10}^+ = 0$ e_{10}^- = 29.94%

Note: d^+ denotes minimum over-achievement of target goal; d^- denotes minimum under-achievement of target goal; e_i^+ and e_i^- represent positive and negative deviations for *'the more the better'* case and *'the less the better'* case, respectively; * denotes target goals of these objectives are set as fixed/single target goals; N/A means not applicable.

The output presented in the third column of TABLE 2 reveals that the objective of minimizing the 'over-achievement' and 'under-achievement' of target goals for each objective is not violated since the values of the achievement function are all equal to zero. The fifth column of TABLE 2 specifically displays the values of the model achievement that fall within the predetermined range of target goals. The robustness of the MCGP model in terms of its ability to satisfy the decision of MCGP-achievement for seven objectives (G2, G4, G5, G7, G8, G9 and G10) that are predefined with these features are captured in the last column of TABLE 2.

G2 and G7 in the MCGP model manage to achieve the highest level from the range of target goals specified for both objectives, which are 50% and 0.04%, respectively. This indicates that both objectives fulfil the decision of '*the more, the better*' achievement with zero deviations. Meanwhile, objective G4, G5, G9, and G10 are considered deviating '*the more, the better*' decision of MCGP-achievement on target goals since the goal achievement for those objectives fail to achieve the highest bound of the specified target goals. It is apparent that objective G4 deviates 15.27% to achieve the highest bound of the target goal of 30%. Objective G5 only achieve 2.21%, which makes 1.79% less to reach the upper bound of the target goal of 4%. Objective G9 and G10 also do not fulfil '*the more, the better*' decision with 2.60% and 29.94% divergence from the highest bound of specified

target goals in the MCGP model. In contrast to the former objectives, objective G8 predefined with '*the less, the better*' decision exceeds 29.09% over the specified lower bound of the target goal value of 30%.

The deviations of certain objectives from the decision of MCGP-achievement, however, do not directly imply that the model proposed is flawed. These findings in some way are parallel with the real decision-making problems situation, where one objective is interrelated to the other objectives, and hence the needs to compromise will emerge. That means, if one objective has fully achieved the decision of MCGP-achievement on target goals, then the target goals of several other objectives will either be achieved or should be released.

RESULTS ON SIMULATION ANALYSIS

The MCGP model of Islamic banks in this study is assumed to face multiple conflicting objectives between economic and social goals with different and changing weights or priorities in the management of financial resources allocations strategy. This is to reflect the needs of the objectives or goals of Islamic banks to be reviewed from time to time in terms of its priority due to the uncertainty concerning internal management factors, general economic conditions, financial landscape as well as the state of competition in the overall banking industry. This supports the previous study by Korhonen (1987) into the dynamic bank portfolio planning model with multiple goals, scenarios, and changing priorities. Monte Carlo simulation analysis was employed to see the impacts of changing weights or preferences of the Islamic bank's objectives as the uncertain parameters to the solutions for the MCGP model.

This analysis leads to selecting the most minimum objective function values among 50 solutions, which indicates that the model manages to minimize the total deviations from the overall set of relevant constraints proposed in the MCGP model. Ten non-dominated solutions are being selected. These solutions are considered the best in terms of the minimum total deviations or dominating all the other solutions for achieving the most minimum total deviations. TABLE 3 presents the results for the ten non-dominated solutions and the variations on the values of the decision variables, which are affected by the changes of weights or priority structures to the economic and social objectives of the Islamic bank. Each of these solutions can be considered as equivalent strategies for financial resource allocations that could be implemented by the Islamic bank. For comparison purposes, the actual allocation of financial resources strategy that the Islamic bank follows during the financial year of 2016 is also considered along the same dimensions.

It is observed that the cash & cash equivalents variable, *A1,* does not differ significantly from the actual value of the Islamic bank's financial statement. On the other hand, the actual value of the interbank placements shows quite a significant difference from the width of the values for the non-dominated solutions ranging between RM96,258 thousand and RM2,033,325 thousand. Some of the weighting structures for decision variables *A1* and *A2* are being equally allocated, while others differ. The decision variable, *A3,* diverges slightly upwards for the solutions obtained through the proposed MCGP model compared to the actual value on the investment in securities issued by the Islamic bank. The variations of the non-dominated solutions for variables *A1, A2,* and *A3* are due to the fact that these variables determine the economic objective of Islamic banks on liquidity, for which the changing weights scenarios were taken into account.

The actual value of the debt-based financing for the financial year 2016 is RM39,189,274 thousand. However, the optimal solutions of non-dominated models for the decision variable, *A4*, produce lesser values, within an interval of RM21,186,340 thousand and RM22,942,350 thousand. The discrepancy occurs due to the restriction imposed in the model that variable *A4* should remain at the levels of previous years, as well as to reflect the needs in reducing the overwhelming dependency of Islamic banks on debt-based financing to generate profits. The constraint imposed to this variable is in view of many opinions by scholars, such as Asutay (2007), Iqbal and Molyneux (2005), Mansour, Jedidia and Majdoub (2015), and others that concern on the dominance of Islamic banking instruments on debt-like financing and the norms of increasing financial allocations to the non-participatory financing modes by an Islamic bank.

The value of variable *A5,* which correspond to equity-based financing, in contrast, yields different decision results from the actual value of the Islamic bank's financial statement. The optimal solutions of non-dominated models produce encouraging values for variable *A5*. The corresponding actual value proves that none of the financial resources allocated for equity-based financing for the fiscal year 2016. The difference can be explained by the fact that the MCGP model in this paper imposes the social goal of enhancing equity-based or PLS financing. This is to intensify the risk-sharing spirit in the practices of contemporary Islamic banks, which seems eluded (Abalkhail & Presley 2000; Ahmed 2002; Mohd Ariffin, Kassim & Abdul Razak 2015). Hence, with the changing on the weights or priorities to this social goal, it can be observed that the values for variable *A5* range between RM12,210 thousand and RM13,020.54 thousand through the optimization of MCGP model. The results of optimal solutions support the aspiration among the proponents of Islamic banking to have a mixture of financing types between the equity-based and the debt-based offered by the Islamic bank (Mansour et al. 2015).

On the liability side, the values for the decision variable, *L1*, are lower compared to the actual value for non-*mudharabah* deposits, whereas it is vice versa for the decision variable *L2*. This condition is clarified by the fact

that both variables determine the level of achievement for the objective to enhance productive investments through deposit funds by the Islamic bank. However, on the social view to encourage risk-sharing and cooperation among depositors and entrepreneurs, the MCGP model requires variable *L2*, which relates to *mudharabah* deposits to maintain the increasing trends of growth rate and not vice versa. As for the variable *L1*, the model imposed that it should remain at the levels of previous years. While the effects on changing weights are not significantly observed for variable *L1* and *L2*, the values produced for the optimal solutions indicate that Islamic bank needs to attract more *mudharabah* deposit from year to year for their financing and investment in beneficial projects with great social impact (Asutay 2012; Hamza 2016). Finally, the values for other decision variables, such as *L3* and *L4* are essential for the completion of the model and mostly matched with the actual values of the Islamic bank due to the rigid constraints imposed on those variables.

MANAGERIAL IMPLICATION

There is an urgent need for the reorientation of Islamic bank towards focusing on the socio-economic objectives that could give impact to the social and economic ends of financial transactions, rather than the mechanics of contract through which financial ends are achieved. Islamic banks should not limit themselves to the structuring of contracts or transactions. Still, they should be viable to respond to the growing socio-economic development needs of various stakeholders within the tenets of the *shariah*. Thus, the proposed model of MCGP for financial resources management in this study has shown that the flexibility of the model would be beneficial to the policymakers at Islamic banks for decision support and planning in view of its ability to incorporate economic and social objectives.

CONCLUSION

This study has presented that the multiple objectives of Islamic banks on economic objectives with the conception of social goals and wellbeing need to be integrated in pursuit of justice and equitable in the allocations of financial resources. Initially, the model on multi-objective was handled through minimizing a positive/negative deviation from a specific or fixed target goal. Nevertheless, the model seems to be inflexible in practice because some decision-makers prefer to set the target goal in a range of interval values to avoid underestimation or overestimation of decision making. Hence, MCGP has been developed to address the multi-objective nature of the Islamic bank's model. The overall findings on the feasible achievements of the multiple objectives model through MCGP verify that Islamic banks could pursue different directions and strategic assumptions from a conventional bank without undermining their commercial value. The objective function for the MCGP optimization with changing weights in this study also yielded compromise solutions for financial resources allocations between contradictory economic and social objectives, where ten non-dominated solutions are considered the best in terms of the minimum total deviations.

Having said that, it is worth highlighting that the process in optimizing a specific objective criterion is always subject to a set of constraints. Thus, the resulting solution will always depend on the completeness of the model in representing the real system, wherein this case is the Islamic banking system. Moreover, it should be accepted that the application of simulated models to capture the changes in the priority weights in this paper still has rooms for improvement in the future study. The very complexity of financial and banking systems and the susceptibility to unplanned variations make it challenging to design adequate representations of the real Islamic banking operations. Despite this limitation, the optimization model on financial resource allocations in this paper potentially opens the prospects of using MCGP model as decision aids to manage financial resources allocations problems in the Islamic bank.

TABLE 3. Results on the objective value and the significant decision variables for the ten non-dominated solutions

Model Solutions	Objective value/ Total deviation (RM'000)	Decision variables (RM'000)											
		A1	*A2*	*A3*	*A4*	*A5*	*A6*	*A7*	*A8*	*L1*	*L2*	*L3*	*L4*
Actual values		3,963,268	100,000	10,585,196	39,189,274	Nil	1,374,876	184,547	286,140	47,822,782	1,939,194	46,278	598,591
Non-Dominated 1	92.12	2,032,634	2,032,634	19,188,430	21,628,020	12,233.65	1,374,876	184,500	286,119	43,649,364	2,327,032	46,278	598.591
Non-Dominated 2	92.12	2,016,244	2,016,243	17,484,310	21,693,370	12,210.76	1,374,876	182,340	286,119	43,649,364	2,327,032	46,278	598.591
Non-Dominated 3	91.37	2,051,410	2,012,083	16,942,330	22,942,350	12,233.70	1,374,876	184,502	286,119	43,649,364	2,327,032	46,278	598.591
Non-Dominated 4	97.63	2,374,367	1,692,284	16,741,080	21,343,250	13,020.54	1,374,876	184,502	286,119	43,649,364	2,327,032	46,278	598.591
Non-Dominated 5	97.63	2,033,325	2,033,325	16,718,010	21,685,340	12,255.74	1,374,876	184,500	286,119	43,649,364	2,327,032	46,278	598.591
Non-Dominated 6	97.63	2,351,397	1,723,232	16,973,620	21,186,340	12,302.93	1,374,876	184,502	286,119	43,649,364	2,327,032	46,278	598.591
Non-Dominated 7	101.00	2,126,183	2,126,183	19,120,870	21,551,350	12,302.93	1,374,876	182,340	258,129	43,649,364	2,327,032	46,278	598.591
Non-Dominated 8	133.52	3,999,104	96,258.32	16,211,450	21,685,340	12,255.74	1,374,876	184,502	286,119	43,649,364	2,327,032	46,278	598.591
Non-Dominated 9	136.37	3,755,627	327,606.30	16,183,030	21,685,340	12,255.53	1,374,876	184,502	286,119	43,649,364	2,327,032	46,278	598.591
Non-Dominated 10	136.37	1,938,730	1,938,730	19,630,760	21,725,250	13,020.70	1,374,876	182,340	236,450	43,649,364	2,327,032	46,278	598.591

Note:

1) Actual values denote figures from the balance sheet of the Islamic bank (BIMB) for the financial year ended 31 December 2016.
2) Non-Dominated solutions derived from models of changing weights or priorities in the simulation process.
3) *A1*= cash & cash equivalents; *A2*= Interbank placements; *A3*= Investment in securities; *A4*= Debt-based financing; *A5*= Equity-based financing; *A6*= Statutory deposits with BNM; *A7*= Fixed assets; *A8*= Other assets; *L1*= Non-*mudharabah* deposits; *L2*= *Mudharabah* deposits; *L3*= Bills and acceptance payable; *L4*= Other liabilities.

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