Model of Optimal Zakat Allocation
by Using Data Envelopment Analysis Approach

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An optimization model of allocation of zakat fund and recipients is developed based on the Data Envelopment Analysis - Resource Allocation Model (DEA-RAM). The quantitative method plays an important role in optimal allocation of zakat delivery programs performed by some zakat institutions; that is by reallocation of initial setting of the zakat fund and beneficiaries' numbers. It raises the needs of improvements in their recent strategies on the programs by the institutions. Zakat institutions, even the government as regulator, should have a clear focus on the poverty-empowerment-based programs in providing needed capitals for poverty empowerment. They are expected to create certain conditions in order to prevent excessive of fund allocation for the charity-based delivery programs.

Keywords: Optimization, Zakat delivery, Resource allocation

1. Introduction

It is the time that development of philanthropy should take benefit from the strategic emerging Technology 4.0 initiated by German government in 2011. Zakat as an Islamic philanthropy has to customize its efforts by digitalization and automation, not only in the collection effort but also in term of delivery the fund to the poor and needy.

The preliminary process in the fund delivery is how to allocate the zakat fund to respective beneficiaries, what the strategy to deliver the fund to different kinds of them. Many institutions of zakat have difficulties in determining appropriate allocation the collected zakat fund. One approach to these problems is to view the zakat fund as a type of resources

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to support the poverty alleviation. In this context zakat institutions should allocate the fund in a certain fraction of charity giving for those indispensable recipients, in contrast to conduct various actions aiming to empower them, for instance providing them with entrepreneur skill.

Demands of a model of suitable or optimal fund allocation by zakat institutions or even BAZNAS could be indicated by some viewpoints. First the institutions may need a tool for implementing some macro level indicators guided by BAZNAS such as ACR (Allocation to Collection Ratio) to an organization or program level. Secondly, they might need a quantifiable indicator on the impacts of zakat delivery, beside socio-economic related, for example the numbers of zakat recipient per program as an indicator of zakat outreach.

Furthermore, an optimal model of zakat allocation plays a significant role in maximizing effectiveness of zakat outreach as well as enhancing efficiency related to the outreach of zakat.

One of important contributions of zakat is to promote the poor and needy to develop Small-Medium Enterprises (SME). As an indication, Yumna & Clarke (2012) described that the Baitul Maal Muamalat Indonesia (BMMI) became a role model of a licensed Islamic philanthropy institution. The institution conducts various programs or projects on charity bases such as aids for natural disaster and direct support for the poor but focusing on economic empowerment basis. Even, they built a partnership with Islamic Development Bank, some philanthropy foundations, and different private and state-based enterprises. This institution develops a program to provide revolving working capital credit for low-income micro-entrepreneurs who were actively participating in Mosque's activities. The concept is to integrate the economic empowerment efforts with enhancing religious belief of the society (charity based) through philanthropy fund delivery, religious capacity development, and encouraging the beneficiaries to SME development.

Hence we focus on the development of an appropriate model for optimizing allocation of zakat fund that is suitable to a preference as a strategy of zakat institution or as a policy of respective government agency in attaining poverty reduction. Such model uses approach of Data Envelopment Analysis (Golany & Tamir, 1995).

2. Literature Review

Resource Allocation

In general resource allocation is utilized to assign accessible resources in an economic way. It is a process and strategy including an institution deciding where limited resources should be used in the production of goods or services. Resource allocation plays important roles to planning, design, and evaluation of product/programs. An optimization model is useful for decision making in providing, utilizing, and allocating resources to fulfill needs and requirements by consumers or parties who use resources (Graves, 1999).

In poverty alleviation or reduction, resource refers to a matter that is utilized to fulfill an individual need; Poverty refers to a situation where one has lack of available resource to fulfill his/her needs (Callan, Nolan & Whelan, 1993). Hence, allocation of resources plays significant efforts in the struggle against poverty. This allocation is a practice of the belief of wealth distribution in Islam (Muhammad, et.al., 2013). By this principle, wealth entrusted by Allah to humans can be requested by Him to be utilized in accordance to His rules and distributed as resources to humanity. As wealth distributed through zakat is very limited compared to the needs to empower those who are entitled to receive it, it is obligatory to allocate zakat resources in optimal way.

Zakat Delivery & Philanthropy Types

Efforts on zakat resources allocation become responsible for both respective institutions and agencies that also conduct collection and management of the zakat fund. In Indonesia, due to the zakat law, they include BAZNAS as a non-structural government agency followed by its local-level agency, as well as several community-based zakat institutions. Besides, the efforts are also held by many informal religion mosque-based foundations.

According to Yumna & Clarke (2012), BAZNAS, the government-based zakat institution in Indonesia, only collected US$ 2.6 million in 2010, where the national potency of the zakat on household income reaches US$ 61 trillion.

The problem, however, is why achievement of the fund collecting is so small while potential fund of the Islamic philanthropy is so huge due to the majority of Muslim population in Indonesia. The major problem is mainly about trust, but it is not merely kind of accountability due to establishment of respective law and regulations, but also trusts on how extent zakat fund could be allocated to intervene poverty by certain strategy of the zakat institution or policy of the government.

The fund of zakat is delivered by allocate the fund for entrepreneurial and/or mustahik empowerment aimed programs, beside for charity giving purposes (Sarasi, 2018). The first allocation is used to productive purposes that are in principle to provide angel and venture capitals to trigger beneficiaries to initiate their SME, so that the Zakat behaves as venture philanthropy. This productive based fund allocation should be determined in optimal way with the allocation for consumptive purposes. These different programs are in line to the Indonesian Law of Zakat Management in 2011. Aimed to reduce poverty, this charity based allocation is still needed to consumptive aids the poor to fulfil their basic needs, e.g. food, health, scholarship. Some previous studies investigated both strategies separately, in term of general philanthropy. Optimization of the fund resource allocation is therefore essential in setting up the program or strategy portfolio conducted by the zakat institutions.

Empowering the poverty through support them in entrepreneurship is believed as the best way, in term of effort on sustainable poverty reduction. Hisrich & Peters (2002) suggested four stages of the entrepreneurial process namely innovation, triggering event, implementation, and growth, which are respectively aimed to identifying and evaluating the opportunity; developing the business plan; determining the resources required; and managing the resulting enterprise.

According to Yumna & Clarke (2012) it is needed to combine or integrate the source of SME development capital from the Zakat fund with the one from commercial fund of the Islamic micro-finance institutions. By using combined sources of funds, the institution could provide both commercial and social services for both extremely and economically active poor clients. The commercial services offer various financial services such as saving products, funding schemes and fee based product for the economically active poor of the population. Meanwhile, the social services are designed to improve the wellbeing of the extremely poor and

to increase their capacities and capabilities in conducting productive activities. After having adequate skills, it is expected that some of the extremely poor can start a new microenterprise and escalate to the wealthier group of the poor. In the context of resource allocation, the fund delivery needs optimization of the allocation.

From the main issues above, the rest of problem is about optimal fund resource allocation to generate numbers of beneficiary as many as possible.

3. Methodology

Quantitative Method based on Data

In the view of operation management of non-profit organization, resource allocation is part of capacity planning to meet supply, i.e., zakat fund resources, and demand, i.e., the poor and needy as potential beneficiaries of the fund. Implementation of the fund resource allocation by the institutions is an objective-based program portfolio Pennypacker (2008) that is a set of fund delivery programs, which have ranges from consumptive-based charity until productive-venture capital for poverty empowerment such as by triggering them to develop SME.

Investigation on the optimal portfolio resource allocation was conducted by a data–oriented non-parametric optimization method of mathematical programming, namely the Data Envelopment Analysis of Resource Allocation Model (DEA-RAM) introduced by Golany & Tamir (1995). This method is originally derived from DEA that become a group of tool for measuring relative technical efficiency, which is based on empirical production efficiency in economics (e.g., Charnes, et.al., 1997). In principle, results of the method are set of optimal reallocation of fund resources, given by the recent allocation, with maximum effectiveness while maintaining efficiency. In this method, optimality is indicated by an inefficiency score of 1. Both DEA-based models were applied by the Solver Add-In embedded in Microsoft Excel.

In this DEA approach, a program of zakat fund delivery can be viewed as a point of Decision Making Unit (DMU) that contains information of a pair allocation of delivered fund and received beneficiary numbers. The

pairs are then reallocated in optimal manner by using the DEA-RAM method so that the pairs are maximum, which are indicated by "moving" the respective points toward an efficient frontier.

Data Envelopment Analysis - Resource Allocation Model (DEA-RAM)

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We analyzed that changes of efficiency and effectiveness of fund delivery program through optimal reallocation (i.e., toward previous or recent allocations) would indicate that the previous or recent program indicators are not optimal. In that case, the method would also show a possibility on presence of trade-off condition between efficiency and effectiveness. We also assumed that allocation of the fund for each beneficiary was constant and it reflected the strategy of the institution in the delivery of fund resources to reach its mission on poverty reduction. The inverse view is the ratio of beneficiary numbers allocated of each fund unit, which we call as "productivity in philanthropy" that tightly relates to the effectiveness.

Basically both the collected zakat fund and the zakat recipient are justified as zakat resources that should be managed optimally by a zakat institution. In mathematical term, maximizing effectiveness and efficiency of the resource allocation can be represented as that the number of potential output $\{y_i\}$ in all decision making unit (*DMU*) *(j=1,...., n)* that can be fulfilled by allocating resource $\{x_i\}$, *i=1, ..., m, j = 1...., n.* The resource allocation considers some empirical production functions based on data in previous period; it also examines limitation of available resource $\{B_i\}$ in every *DMU* for each $i \in C$, where C is controllable resources. As the DMU will be enforced to or near the *frontier* of empirical production, so the second objective of deciding efficient operational efforts can also be reached.

A set of mathematical formulation represents the above scenario called as *DEA RAM* Golany & Tamir, 1995) as follow:

Objective function:

$$\text{Maximize } Z = \sum_{j=1}^{n} y_i \qquad (1)$$

subject to some constraints:

$$\sum_{k=1}^{n} y_k \cdot \lambda_{kj} \geq y_j \quad \text{for each k and j} \quad (2)$$

$$\sum_{k=1}^{n} x_{ik} \cdot \lambda_{kj} \leq x_{ij} \quad \text{for each i and j} \qquad (3)$$

$$\sum_{k=1}^{n} \lambda_{kj} = 1 \qquad (4)$$

$$\sum_{k=1}^{n} x_{ij} \leq B_i \qquad (5)$$

$$\lambda_{kj}, x_{ij}, y_i \geq 0 \quad \text{for each k, j, i} \quad (6)$$

where:

- Z = maximum value of y
- x = zakat fund to be delivered
- y = number of zakat recipient
- λ = weights of x and y variables
- B = total of available zakat fund

Combination of objective function (1) and constraints (2) ensure maximum output target. Constraints (3) and (4) ensure that each identified output will identify feasible and minimum resource allocation. Hence efficient performance will be allowed for n DMU. Constraint (5) represents a condition that all fund delivered through related programs (=*DMU*) should be less than or same to the total of available zakat fund. Non-negativity of all variables is described by the constraint (6).

The model also provides additional constraint of assumption that ratio of allocated fund for each recipient does not change during the optimal reallocation. This ratio represents strategy of the institution in the zakat

delivery. This model was applied by using *Solver Add-In* in *Microsoft Excel*.

Measuring Efficiency and Effectiveness

In principle, efficiency is measured prior to and after reallocation of zakat resources. Efficiency scores can be provided by using DEA method, which will then be plotted in efficiency space (Figure 1 below).
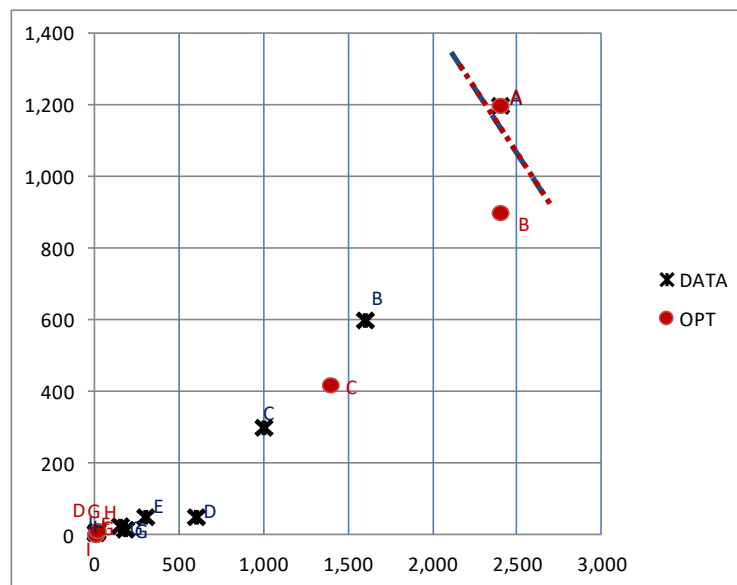

Figure 2: Efficiency space of Zakat Fund and Recipient Number Allocations prior to (blue dots) and after optimal reallocation, where black dotted line is hypothetical efficient Frontier

Meanwhile, effectiveness is indicated by difference between zakat recipient numbers that are counted prior to and after the optimal zakat reallocation.

We applied this methodology to some cases of Zakat institutions in Indonesia to study the effects of a change, i.e., from current resource allocation to optimal one. This case study method is suitable since there is at recent little investigation on fund resource allocation in context of zakat institution in Indonesia. Objective of this preliminary research is to find out what is happening in the changes, to seek new insights as well as

to generate ideas and hypotheses for new research (e.g., Runeson & Hoest, 2009). As suggested by Yin (2003), we emphasize systematically in detailed analysis on the quantitative resource allocation by zakat institutions and programs to the context of providing capital for poverty reduction basis in Indonesia.

4. Results

Cases and Data

We tried to employ the model in two cases that are two different sets of program conducted by two zakat institutions to represent a zakat institution conducting specifically on poverty empowerment efforts.

These all cases were assumed to represent diversity of activities of the Zakat institutions in Indonesia. Case-1 represents a zakat institution which performs both charity and poverty empowerment-type programs (denoted as program A through I; see Table 1). The first type contributes the poor and needy beneficiaries with their basic needs in different aspects such as religion, socio-economic, education, and health. Poverty empowerment as another zakat-type programs were represented through encouraging, coaching, providing an angel and venture capitals for the beneficiaries to develop an SME in farming, stockbreeding, fisheries, trading, and other kinds of livelihood up to their skill and interest. In this context, Case 2 is related to a group of entrepreneurship-based programs in farming, stockbreeding, and small trading enterprise development, respectively, those were conducted by a licensed national-level institution. In each of all cases, we analyzed nine different programs (denoted as program A through I; see Table 2).

We assumed that each institution could manage the fund resource in accordance to type and objectives of programs, which have ranges from a direct (general charity) fund for the beneficiaries, purchases of charitable goods, direct and indirect costs of program, as well as forms of angel and venture capitals for the SME development. Situation of each case was identified by two parameters related to the allocation, i.e.: (1) allocated fund resource as an input of the programs, and (2) the beneficiary numbers of the fund as an output. We analyzed current condition by observing patterns of changes on effectiveness and efficiency indicators related to the two parameters by using the DEA-RAM method.

Table 1: Data of Zakat Delivery Programs of Case-1

Zakat Delivery Program	Zakat Fund Allocation	Recipient Numbers (persons)	Fund Allocated/ Person
A	20.83%	52	855,92
B	5.21%	54	205,29
C	22.92%	569	86,35
D	20.83%	804	55,56
E	3.13%	130	51,48
F	15.63%	1.875	17,88
G	2.08%	298	14,99
H	3.13%	583	11,49
I	6.25%	1.765	7,60
	100.00%	6.132	

Table 2: Data of Zakat Delivery Programs of Case-2

Zakat Delivery Program	Zakat Fund Allocation	Recipient Numbers (persons)	Fund Allocated/ Person
A	3.59%	85	1,313
B	4.25%	61	2,165
C	5.59%	52	3,336
D	6.70%	47	4,429
E	16.26%	82	6,197
F	20.50%	89	7,192
G	21.19%	71	9,268
H	12.25%	36	10,473
I	9.66%	20	15,000
	100.00%	542	

Optimal zakat allocation

The results of resource allocations of Case-1 are presented by Figure 2 and Figure 3 below. At previous, the zakat institution allocated large portion of the fund but for small numbers of beneficiaries in the first two poverty-empowerment-based programs (Program A and B). The optimal reallocation then suggested decreases of the fund allocation for such kind of programs and increases both of fund and beneficiary numbers of the rest five charity-based programs (Program E to I). However, it was unusual that the pattern of optimal reallocation of the numbers of

beneficiaries in the charity-based programs were as high as near-maximum, resulting almost empty of the beneficiaries in rest five programs that are based on poverty-empowerment.

We indicated that one or more points were positioned in the efficient frontier, which represented optimality of these pairs of allocation in previous condition. Other points having inefficiency scores of more than 1 are assumed to be in sub-optimal conditions.

Data of Program-C and F showed efficient conditions of the pair allocations of fund and beneficiary numbers, which their points were indicated in the previous efficient frontier. However, optimization then showed reallocation of almost of all programs, so that the-E was finally the maximum efficient and effective program, although the allocation pair of Program-F remained. The three other charity-based programs (i.e., Program-G, H, and I) showed lots of increase of efficiency.
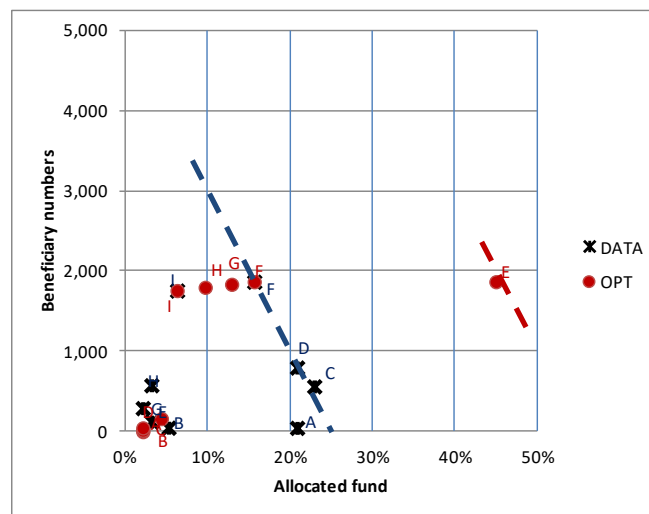

Figure 2: Pairs of allocation of the fund and beneficiary numbers of each program in recent and optimal conditions (note: dashed line is a hypothesized efficient frontier)

These increases of efficiency of the three previous programs are induced by lower ratios of allocated zakat fund per beneficiary numbers. In other sides, the larger ratios affect worse efficiencies of the reallocated pairs of the four poverty-empowerment-based programs (i.e., Program-A to D), which were showed by lowering efficiencies of the four points toward

almost zero.

Impacts of changes of the ratio of allocated fund-per-zakat-recipient (as an indication by program) on both indicators due to the optimal reallocation are seen in Figure 3 (above and below, respectively).

Charity-based programs that have lower ratios are able to increase their allocated fund as well as zakat recipient numbers. In turn, the poverty-empowerment-based programs that have larger ratios indeed should decrease the allocated fund and zakat recipient numbers.
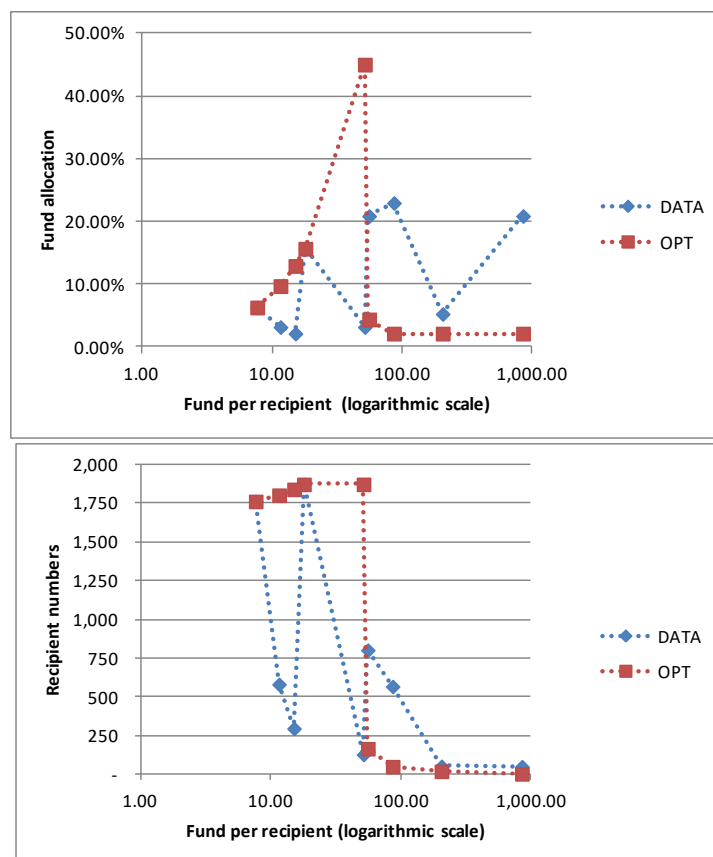

Figure 3: Zakat fund allocation (above) and recipient numbers (below) of Case-1 as function of ratio of fund per recipient

In a different circumstance, Case-2, the zakat institution executed their fund delivery programs that were focused on providing the capitals for development of entrepreneurship as attempts on poverty reduction. Scatter diagrams (Figure 4) showed different spread patterns of allocation

pairs of delivery fund and beneficiary numbers. Many of zakat delivery programs of the case showed un-optimized conditions. Next, the DEA-RAM had suggested improvement through fund resource reallocation resulting in increases of both efficiency and effectiveness in all of the three cases. However, the optimization indicated that previous allocations were actually almost optimal as changes of the allocation pairs in optimal condition were not substantial. In addition, the efficient frontier did also not change due to the reallocation.
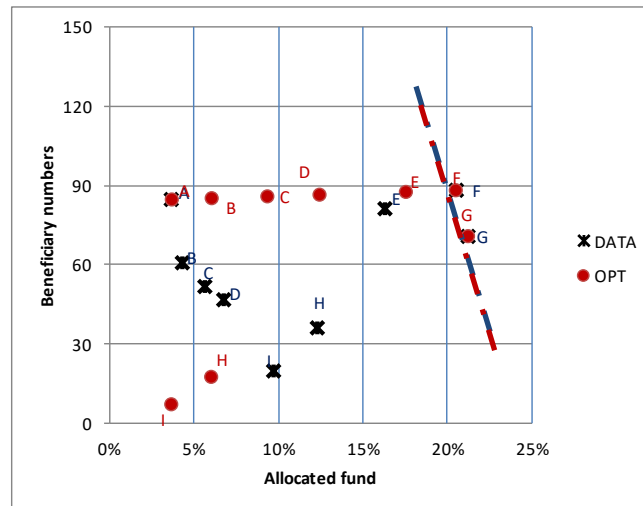

Figure 4: Pairs of allocation of the fund and beneficiary numbers of each program in recent and optimal conditions (note: dashed line is a hypothesized efficient frontier)

Change of zakat fund distribution over the ratio of fund-per-zakat-recipient indicated by programs as the result of optimal reallocation is seen in Figure 5 (above), while resulted change of zakat recipient is observed in Figure 5 (below).

Impacts of changes of the ratio of allocated fund-per-zakat-recipient as per indicated program on both indicators due to the optimal reallocation are seen in Figure 5 (above and below, respectively).
Again, zakat delivery programs that have lower ratios of allocated fund-per-zakat-recipient are able to increase their allocated fund and zakat recipient numbers. However, the zakat delivery programs that have larger ratios indeed should decrease the allocated fund and zakat recipient numbers.
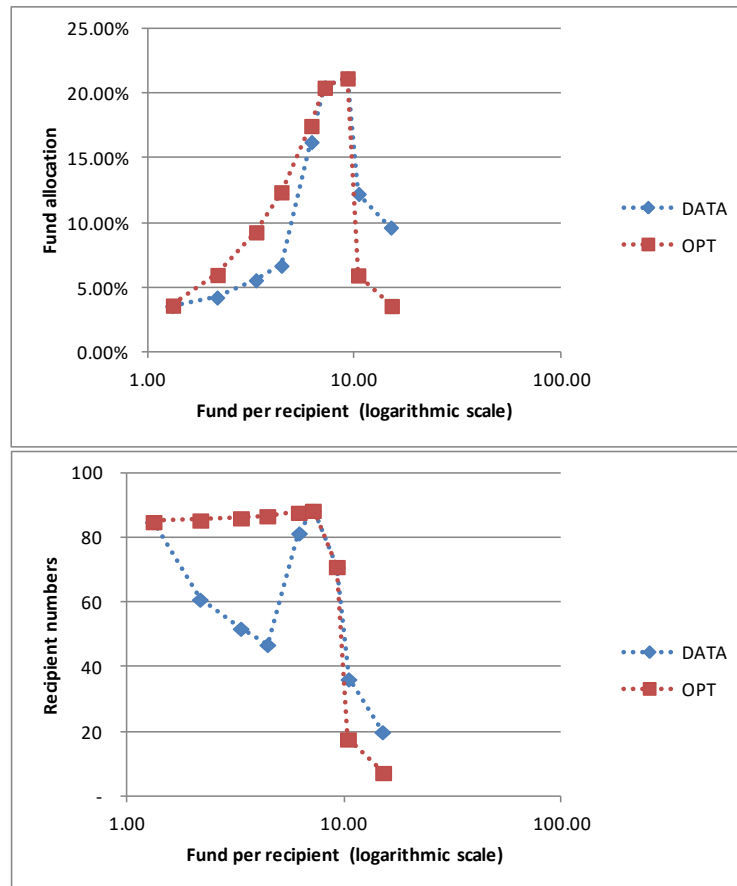
Figure 5: Zakat fund allocation (above) and recipient numbers (below) of Case-2 as function of ratio of fund per recipient

5. Discussions

Description of the first of two cases showed that Zakat institutions typically conduct different types of zakat programs so that they are not able to allocate their fund resources optimally into this program portfolio. It is suggested that the institutions should design their fund delivery programs so that the pairs of fund and beneficiary numbers allocations of every program will develop optimal efficiency and effectiveness. In term of DEA-based method, these criteria can be illustrated in an objective diagram (see Figure 2 and 4 for each case), where an efficient and effective program can be plotted as a point of Decision Making Unit (DMU) lying onto or at least nearby an assumed line of efficient frontier.

Using the illustration, it was indicated that the institution of case-1 did not pay much attention on poverty empowerment by providing less capitals for SME development. This is indicated by some DMUs on poverty-empowerment-based programs were far from the efficient frontier, even in optimal reallocation condition, i.e., Program A-D.

The second case had exhibited characteristics of fund and beneficiary allocations in the institutions or program groups that focused on poverty empowerment through provision of needed capitals of SME development. All of the programs should be directed to enhance "productivity in philanthropy" to reach maximum beneficiary numbers given by the allocated fund resource. Trade off may also be occurred when there are needs of program to provide high capital but also need to be endorsed since they have high technology, as an example.

Lower ratio allocated fund per beneficiary number unit (or "productivity in philanthropy") attached to the charity-based delivery programs could trigger negative impacts in term of decreases of both fund and beneficiary allocations for the poverty-empowerment-based programs. This situation would have major impacts on weakening the empowering poverty in term of the poverty reduction efforts. To resolve this problem, the zakat institutions, even BAZNAS as regulator, might have a clear focus on the poverty-empowerment-based programs in providing needed capitals for poverty empowerment. They are expected, for example, to create an upper threshold or a certain constraint for fund allocation of the charity-based delivery programs. In other side, they should also encourage enhancing the "productivity in philanthropy" of programs that develop entrepreneurship in term of poverty reduction efforts.

It was proved by some numerical experiments using the DEA-RAM, ideal condition of effective and efficient pairs of allocation were reached when the charity-based programs provide less zakat fund for more beneficiary numbers, balancing with the poverty-empowerment-based programs deliver more zakat fund but reaching less beneficiary numbers. Other ideal situation is that the fund resource is allocated homogeneously for all available programs, while beneficiary number allocations of the charity-based programs are more than ones of poverty-empowerment-based programs. In these optimal conditions, the reallocation by DEA-RAM will result this pair of zakat resource allocation relatively unchanged.

6. Conclusions

We have demonstrated a tool of data optimization based analysis in the resource allocation perspective on the contribution to zakat delivery management, especially to support efforts on optimal allocation of charity giving and mustahik empowerment type programs in a zakat institution level.

In general, all case studies on the zakat institutions in Indonesia showed needs of improvements in their recent strategies on the programs aimed to allocating the collected fund resources to respective beneficiaries. These conditions were indicated by the changes in efficiency and effectiveness scores in the optimal reallocation evaluation.

In term of tradeoff between charity giving and mustahik empowerment types of zakat delivery programs, it is necessary for zakat institutions to create an upper threshold as a constraint to prevent excessive fund allocation for the charity-based programs. In other side, they should also encourage enhancing the "productivity in philanthropy" of programs that develop entrepreneurship with efficient cost. These two points would become crucial hypotheses for next researches that could fulfill a gap of knowledge on this research topic recently.

In practice, the zakat institutions might have clear strategy on allocating their collected fund resources to contribute the poverty reduction efforts.

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