A Formulation of Priority – Based Financial Allocation Model for Student Development Activities in SPED Centers

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Abstract

Special Education (SPED) was established to meet the needs of children with different types of disabilities and other special needs, and designed to adhere to necessities which mass education was incapable to support. In the Philippines, there are 648 public SPED centers nationwide (DepEd, 2017) and each center has the authority to determine which activities to implement and how much budget should be allocated for each activity. Department of Education (DepEd) obliged each SPED center to utilize the apportioned percentage of the great subsidy for student development activities to ensure that the needs of the children will be provided. Therefore, accurate decision making in prioritizing student development activities for SPED is necessary to ensure that the allocation of funds in each center is geared towards the goals and objectives of the central SPED unit. However, based on data, selection of activities and allocation of budget per activity varies among centers since the current system of each center regarding prioritization of activities and allocation of budget was not clearly defined because no certain basis has been established. Therefore, prioritization of activities and allocation of resources must be developed. Given this condition, the researchers aim to formulate a priority-based financial allocation model for student development activities in SPED centers. Using statistical analysis, the researchers were able to identify significant factors that must be considered in formulation of model such as (a) number of students served (b) number of activities implemented (c) types of disabilities catered and (4) amount of funds received.

Keywords:

Special education, resource allocation, goal programming, prioritization

1. Introduction

Special Education (SPED) started in the Philippines in 1907. It was established to meet the needs of children with different types of disabilities and other special needs, and designed to adhere to necessities which mass education was incapable to support. Many children with disabilities are unwilling to participate in activities that would benefit them because they are insecure, embarrassed, or lack confidence in their skills, perceived or real (Desotelle, 2008). They tend to withdraw from society, therefore development of their physical and motor skills, social skills and intellectual skills rely mainly on the programs and services of SPED centers. Thus, the Department of Education obliged each SPED center to utilize the apportioned percentage of the grant subsidy for student development activities as to ensure that these children will be exposed to educational visits, camp activities, sports activities, students training and other SPED related activities. However, although financial subsidy is provided, public financing of education is almost always inadequate and rarely able to cover all necessary expenses (Behrman, Deolalikar & Soon, 2001).

Issues on financing education most likely to occur as educational agencies increased their programmatic commitments to special education whereas these commitments have resulted to a need of large sums of money (Favel, 1988). Meanwhile, in the master thesis that covers selected special schools in Metro Manila, it was stated that financial costing should not be an issue. Instead, administrators should carefully plan for cost effectiveness schemes of their school, which should be the aim of all forms of education (Lin, 2003). Planning for cost effectiveness within a school brought a need to optimally relate financial resources to desired outcomes. The question of how best to achieve goals through effective resource allocation became even more critical (Pan, Rudo, Schneider & Hansen, 2003). A management that

functions on the basis of a systematic plan and that follows an orderly priority system is certainly better suited to administering public financing rather than a poorly organized management system (Behrman, Deolalikar & Soon, 2001).

Hence, this research was conducted with the purpose of creating clear and accurate solutions in prioritizing student development activities, furthermore formulating a mathematical model as to achieve optimum allocation of funds. Effective resource allocation starts with the alignment of goals, priorities, and activities of education decision makers at all (Pan, Rudo, Schneider & Hansen, 2003).

2. Methodology

Student development activities were classified into five student development programs. Analytical hierarchy process was utilized to obtain the weight contribution of each student development program in the achievement of the organizational goal of the SPED unit. In view of the fact that determination of general priority weight values involves group decision making, the population consisting of 81 teachers from the seven SPED centers participated in the study and expressed their own subjective preferences. The Expert Choice software was used to translate the 81 individual preferences to 81 individual priorities. Nevertheless, as priorities would sound rational only if derived from consistent judgments, a consistency check was applied. The aforementioned software was utilized to test the consistency of individual priorities. 18 out of 81 teachers passed the consistency test. These 18 individual priorities were used to develop a general priority weight values for student development programs. Geometric mean was applied to these priorities to form a single value. Geometric mean is more consistent with the meaning of priorities in AHP (Adamcsek, 2008). In line with this, percent goal achievement for each SPED center was computed using the general priority weight values as the target ratio for fund allocation.

As each center has the authority to determine which set of activities to implement and how much budget should be allocated for each activity, variations in terms of percentage goal achievement among centers exist. However, any kind of difference to observed in a set of data could possibly be due to chance and not necessarily reflect a significant pattern. Therefore, significance testing was used to help make a judgment about a claim. Analysis of variance, Tukey's HSD test and regression analysis were utilized to conduct comparative analysis among schools.

Moreover, goal programming was utilized to achieve a mathematical model which yields a satisfying solution on the allocation of funds for activities. The model considered the budget limit, expenses incurred to cover an activity, priority weight values of activities with respect to the affiliated program, general priority weight values of programs with respect to the organizational goal, population size, and the percentage goal achievement. Post optimal analysis was conducted to determine critical variables that could significantly affect the optimality of the objective value. Lastly, a database has been developed in MS Access which was directly linked to Lingo 13.0 software to allow the intended users to generate allocation solutions on their own. Guidelines on the prioritization and allocation of funds were established to strengthen the possible implementation of this study.

3. Results and Discussion

3.1. Result of Analytical Hierarchy Process (AHP)

The aggregated result from AHP is shown in Table 1. The general priority value of each student development program was translated into percent fund allocation. Based on analysis, on account that the proposed breakdown of allocation is aligned with the organizational goal and objectives of the central SPED unit, measuring the percentage goal achievement in terms of fund allocation was made feasible.

Table 1. Result of AHP

Student Development Program	General Priority Weight Value	Priority Rank	Percent of Allocation
School retention and promotion	0.137	5	13.7%

Basic program	0.260	1	26.0%
Individual program	0.257	2	25.7%
Local culture, arts, music and media	0.150	4	15.0%
Health and physical development	0.196	3	19.6%
TOTAL	1.00	---	100%

The general priority weight value of each student development program serves as a target ratio of allocation in order to achieve the organizational goal. Thus, any deviations from the target ratio of allocation will yield to a deviation in achieving the organizational goal. Hence, percentage goal achievement can be computed given the formula:

$$\textbf{Overall percentage goal achievement} = \left(\sum_{i=1}^{5} G_i\right) x\ 100\ \%$$

$$However[1],\ G_i = \begin{cases} G_i, & \text{if } G_i < T_i\ T_i \\ , & \text{if } G_i > T_i \end{cases}$$

Where T_i is the target ratio of fund allocation for program *i*

G_i is the actual ratio of fund allocation for program *i*

Target ratio of fund allocation for each program reflects the weight contribution of each program in achieving the goal. Allocating 90% of your funds in a program whose weight contribution in achieving goal is 10% would still result to a goal achievement of 10% for that program. Over-funding a certain program will not increase its weight contribution in achieving the goal. Thus, the maximum value for goal achievement in each program should not exceed the target ratio of funds allocation. To further visualize the use of equation, Table 2 is presented. For the computation of the actual ratio, the fund allocated to a certain program is divided by the total amount of fund. For illustration:

$$Actual\ Ratio = \frac{PHP\ 6,500}{180,500} = 0.0360\ PHP$$

Table 2. Computation of Percent Goal Achievement based on Programs

Programs	**Fund Distribution SY 2012 - 2013**	**Actual Ratio, G_i**	**Target Ratio, T_i**	**Is $G_i > T_i$**	**Percent Goal Achievement**
School Retention and Promotion	PHP 23,000.00	0.1274	0.137	No, use $G_i = G_i$	12.74%
Basic Program	PHP 6,500.00	0.0360	0.260	No, use $G_i = G_i$	3.60%
Individual Program	PHP 60,000.00	0.3324	0.257	Yes, use $G_i = T_i$	25.70%
Health and Physical Development	PHP 40,000.00	0.2216	0.196	Yes, use $G_i = T_i$	19.60%
Local Culture, Arts, Music and Media	PHP 51,000.00	0.2825	0.151	Yes, use $G_i = T_i$	15.10%
TOTAL	PHP 180,500.00	1.00	1.00	**---**	**76.74%**
DepEd Fund (20% of PHP 500,000.00)	PHP 100,000.00				
Sponsors	PHP 80,500.00				

The same computation was done with other student development programs and with six other SPED centers. Given with the computed overall percentage goal achievement of the seven SPED centers, Gomez Elementary School has the highest percentage achievement with 80.24%, followed by Rizal Elementary School with 76.74%, next is Albert Elementary School with 72.43%, then Fugoso Elementary School with 69.92%, followed by Burgos Elementary School with 66.57%, Lukban Elementary School comes next with 63.59%, and lastly Hizon Elementary School with 51.57% goal achievement. Measuring the percentage goal achievement of each SPED center in terms of fund allocation was priority – based.

3.2. Result of Analysis of Variance (ANOVA)

Subsequent to the computation of the percentage goal achievement, the paper aims to determine the significant difference between the percentage goal achievements among SPED centers. Three-year data provided by the Manila SPED office was used to further compute for the percentage goal achievements of the seven SPED centers for the previous years which were then subjected to ANOVA. The level of significance used is 0.05 or 5%. This level of significance is normally used since it is conventional. In this study, the null hypothesis (H_o) is: There is no significant difference between the percentage goal achievements among centers; and, for the alternative hypothesis (H_a): there is a significant difference between the percentage goal achievements among centers. With the aid of Excel, results were generated easily and are presented in Figure 1:

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
A. Albert	3.00000	2.13970	0.71323	0.00011
Fugoso	3.00000	2.10310	0.70103	0.00017
J. Lukban	3.00000	1.83370	0.61123	0.00046
J. Rizal	3.00000	2.30490	0.76830	0.00004
M. Hizon	3.00000	1.62780	0.54260	0.00071
P. Burgos	3.00000	1.92960	0.64320	0.00039
P. Gomez	3.00000	2.28940	0.76313	0.00117

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0.12352	6.00000	0.02059	47.11875	0.00000	2.84773
Within Groups	0.00612	14.00000	0.00044			
Total	0.12964	20.00000				

Figure 1. Result of Analysis of Variance (ANOVA)

Based on the result, it can be seen that F value is greater than Fcrit and the p value is less than the level of significance, therefore there is enough statistical evidence to reject the claim that there are no significant differences between the percentage goal achievements among centers. However, results from ANOVA only show whether or not significant differences exist, it does not show whether the data are all different from each other or at least one data is different from another. Thus, it is only proper to figure out exactly where the differences lie in these data. To do so, Tukey's test was applied. The Tukey's HSD test indicates that the difference between Albert and Lukban, Albert and Hizon, Albert and Burgos, Fugoso and Lukban, Fugoso and Rizal, Fugoso and Hizon, Fugoso and Gomez, Lukban and Rizal, Lukban and Hizon, Lukban and Gomez, Rizal and Hizon, Rizal and Burgos, Hizon and Burgos, Hizon and Gomez, Burgos and Gomez are all significant.

3.3. Result of Regression Analysis

Further investigation is necessary to find out what causes the differences among means of the percentage goal achievement of the seven SPED centers. In view of the fact that each center varies with the number of students served (X_1), number of activities implemented (X_2), number of type of disabilities catered (X_3) and amount of sponsorship funds received (X_4), these quantifiable variable data could possibly be the factors for having significant differences. Multiple regression analysis was used to determine whether the aforementioned variables are good predictors of percentage goal achievement therefore causing the differences among centers. And from the result presented in Figure 2, it can be inferred that taking into account all of the abovementioned variables, their result is insignificant as indicated by the value of the adjusted R square.

Regression Statistics	
Multiple R	0.8334
R Square	0.6946
Adjusted R Square	0.0837
Standard Error	0.0906
Observations	7

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	-0.1424	0.4851	-0.2935	0.7968
X Variable 1	-0.0026	0.0018	-1.4086	0.2943
X Variable 2	0.0486	0.0302	1.6113	0.2484
X Variable 3	0.0785	0.0571	1.3745	0.3030
X Variable 4	0.0000	0.0000	1.8146	0.2112

Figure 2. Result of Multiple Regression Analysis

However, to test if there are still improvements that can be made from the regression analysis, backward elimination approach was conducted. Backward elimination involves the removal of variables to test if there are any changes to the model; this process is repeated until no further improvement is possible. The criterion for selecting which among the variables will be deleted first is dictated by the p-value. The variable with the highest p-value will be deleted, in this case X3 (number of type of disabilities) was deleted. The model which was now left with three variables was subjected to regression analysis. Result of the backward elimination regression is presented in Figure 3.

Regression Statistics	
Multiple R	0.6372
R Square	0.4060
Adjusted R Square	-0.1879
Standard Error	0.1031
Observations	7

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	0.4894	0.1766	2.7721	0.0694
X Variable 1	-0.0002	0.0006	-0.2874	0.7925
X Variable 2	0.0119	0.0160	0.7444	0.5106
X Variable 4	0.0000	0.0000	1.1839	0.3217

Figure 3. Result of Backward Elimination Regression Analysis

3.4. Goal Programming Formulation

In reality, allocation of financial resources is not based solely on the goals and objectives of the organization. It is inevitable that other constraints such as population and estimated cost should be looked at. Thus, in terms of fund allocation, it is presumable not to attain the organizational goal hundred percent. Therefore, considering other restrictions, one begins to ask – does the current fund allocation in each center yield to an optimal percentage of goal achievement? A mathematical model was formulated to determine whether fund allocation of the seven SPED centers is at their optimal state. The researcher used Goal Programming (GP) in formulating a model. Despite the fact that GP model attempts to find a satisfying solution rather than an optimal solution, it best suits the study as it considers multiple and conflicting objective measures.

Resource allocation is a process of allocating finite resources despite of undoubtedly infinite needs. In this case, the decision variables that the study seeks to determine are:

A_i = the amount of funds allocated for activity *i* under the School Retention and Promotion Program at a specific SPED center.
B_i = the amount of funds allocated for activity *i* under the Basic Education Program at a specific SPED center.
C_i = the amount of funds allocated for activity *i* under the Individual Program at a specific SPED center.
D_i = the amount of funds allocated for activity *i* under the Local Culture, Arts, Music and Media Program at a specific SPED center.

E_i = the amount of funds allocated for activity *i* under the Health and Physical Development Program at a specific SPED center.

Allocation decision is a choice of how much funds should each student activity receive under significant constraints. The constraints considered in the study are the following:

A. Constraint 1: Budget Constraint

The sum of funds allocated to all activities should not exceed the budget available for student development activities at a specific SPED center.

$$\sum_{i=1}^{n} (A_i+B_i+C_i+D_i+E_i) \leq S$$

Where:
S = budget available for student development activities

B. Constraint 2: Student Development Program Weight Contribution Constraint

The sum of funds allocated to all the activities under a specific program in proportion to the total funds available for student development activities at a specific SPED center should be at least equal to the general priority weight value of the said program.

$$\sum_{i=1}^{n} A_i - W_a \sum_{i=1}^{n} (A_i+B_i+C_i+D_i+E_i) \geq 0$$

Where:
W_a = general priority weight value of school retention and promotion program

C. Constraint 3: Activity Priority Constraint

Each student development activity has a corresponding individual priority weight value based on its importance to the affiliated program. Thus, the amount of funds allocated for the activity of a certain program in proportion to the sum of funds allocated for all activities of that program should be at least equal to the individual priority weight value of that activity at a specific SPED center. Activity priority values were obtained using AHP as teachers made pairwise comparison of activities considering their importance to student development programs.

$$A_i - F_{ai} \sum_{i=1}^{n} A_i \geq 0$$

Where:
F_{ai} = individual priority weight value of activity *i* with respect to school retention and promotion program

D. Constraint 4: Population Priority Constraint

The amount of funds allocated for the activity should be at least equal to the proportion of the number of beneficiaries of that activity and the total number of beneficiaries of all student development activities at a specific SPED center.

$$A_i - R_{ai} \sum_{i=1}^{n} (A_i+B_i+C_i+D_i+E_i) \geq 0$$

Where:

R_{ai} = ratio of the number of beneficiaries in activity *i* under school retention and promotion program to the total number of beneficiaries in all activities

E. Constraint 5: Expense Constraint

The amount of funds allocated for the activity of a certain program should be at least equal to the expenses incurred to cover the activity at a specific SPED center.

$$A_i \geq M_{ai}$$

Where:

M_{ai} = expenses incurred to cover activity *i* under school retention and promotion program

F. Constraint 6: Percentage Goal Achievement Constraint

The amount of funds allocated for all student development activities should yield to goal achievement of not lower than the computed percentage goal achievement of a specific SPED center from the previous section of this study.

$$[G_a + G_b \ldots + G_e] \geq J$$

$$G_a \ldots G_e = \begin{cases} G_a \ldots G_e, & \text{if } G_a < T_a \ldots G_e < T_e \\ T_a \ldots T_e, & \text{if } G_a > T_a \ldots G_e > T_e \end{cases}$$

Where:

G_a = the sum of funds allocated to all the activities under school retention and promotion program in proportion to the sum of funds allocated to all activities

T_a = general priority weight of school retention and promotion program

J = computed percentage goal achievement of a specific SPED center from the previous section of this study

F. Constraint 7: Non Negativity Constraint

This is a restriction in the programming model stating that negative values for decision variables cannot exist in a solution.

$$A_i, B_i, C_i, D_i, E_i \geq 0$$

3.4.1. Model Formulation using Goal Programming

The purpose of this goal programming model is to allocate the apportioned percentage of the financial subsidy across several student development activities according to a set of stated goals.

Multiple Goals:

- Minimize overachievement of the total available budget for student development activities at a specific SPED center.
- Minimize underachievement of the sum of funds that should be allocated to all activities in accordance to the general priority weight value of their affiliated programs at a specific SPED center.
- Minimize underachievement of the amount of funds that should be allocated to a particular activity in accordance to its individual priority weight value at a specific SPED center.
- Minimize underachievement of the amount of funds that should be allocated to a particular activity with respect to its population ratio at a specific SPED center.

- Minimize underachievement of the incurred expenses to cover a certain activity at a specific SPED center.
- Minimize underachievement of the computed percentage goal achievement of a specific SPED center.

In this study, the researcher preferred the preemptive method for goal programming. The preemptive method starts by prioritizing the goals in order of importance. The model is then optimized, using one goal at a time such that the optimum value of a higher-priority goal is never degraded by a lower-priority goal. Through discussion with the Manila SPED Supervisor, the researcher was able to know which allocation constraints should be prioritized. The following list summarizes the six levels of priority assigned in order: $P_1 > P_6 > P_2 > P_5 > P_3 > P_4$.

P_1: Budget Constraint.
P_6: Percentage Goal Achievement Constraint.
P_2: Student Development Program Weight Contribution Constraint.
P_5: Expense Constraint.
P_3: Activity Priority Constraint.
P_4: Population Priority Constraint.

With the aid of Lingo 13.0 software, the following results were generated from the model: A. Albert can be optimized by 8.07%, Fugoso can be optimized by 30.078%, J. Lukban can be optimized by 30.08%, J. Rizal can be optimized by 22.36%, M. Hizon can be optimized by 28.93%, P. Burgos can be optimized by 33.42% and P. Gomez can be optimized by 19.75%. This would mean that the current allocations for the aforementioned SPED centers were not optimally aligned with the organizational goal and objectives of the central SPED unit as opportunities for improvement were generated.

Values for the reduced cost of all critical values for the seven SPED centers were obtained from the solution report of Lingo software. Moreover, it is evident that all of the critical variables are part of the Student Development Program Weight Contribution Constraint. It can then be inferred that the aforementioned constraint takes control of the model in view of the fact that this constraint limits the other goal constraints that are subsequent to it from being satisfied as seen during the model validation. Also, any changes to the variables affiliated to the abovementioned constraint will result to a significant increase in the objective function.

As much as the formulated model would be of great help to each SPED center under study, it would be an obstructive solution if the intended beneficiaries could not use it. Since the generated solution from the formulated model is not applicable at all times in view of the fact that quantifiable data are variables and most likely to change, a database was created as shown in Figure 4.

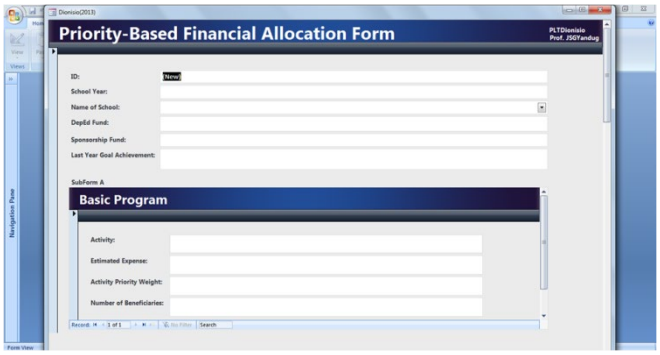

Figure 4. Database for Priority-Based Allocation Form

The database allows its user to input data such as the DepEd fund, sponsorship funding, last year goal achievements, activities, estimated expenses, activity priority weight values and number of beneficiaries.

4. Conclusion

The main purpose of this paper was to formulate a financial allocation model for student development activities in SPED centers. Different approaches using Industrial Engineering tools have been used for this the study. By conducting surveys, initial interviews, and acquisitions of historical data for the seven SPED centers under study, the researcher has been able to gather enough as a solid reference in creating the corresponding program.

This study began by determining the weight contribution of each student development program in achieving the organizational goal. From the result of AHP with the aid of Expert Choice software, it can be inferred that the School Retention and Promotion Program has a weight contribution of 13.7%, the Basic Program contributes 26.0%, the Individual Program contributes with 25.7%, the Local Culture, Arts, Music and Media puts in 15.0% and the Health and Physical Development Program puts in 19.6%.

Moreover, this proposed distribution served as a target ratio in computing for the percentage goal achievement. The computed percentage goal achievements of the seven SPED centers were as follows: J. Rizal achieved 76.74%, A. Albert achieved 72.43%, M. Hizon achieved 51.57%, P. Burgos achieved 66.57%, J. Lukban achieved 63.59%, Fugoso achieved 69.92%, and P. Gomez achieved 80.24%. Determination of the current status of SPED centers will be of assistance in identifying opportunities for improvement that will be used in the model.

However, prior to the formulation of allocation model, this paper sought to answer whether there are significant differences between the percentage goal achievements among centers. With the use of ANOVA, it has been statistically proven that there are significant differences. Nonetheless, Tukey's HSD Test was used to determine whether the data is different from all other data or at least one data is different from another. As a result, Albert and Lukban, Albert and Hizon, Albert and Burgos, Fugoso and Lukban, Fugoso and Rizal, Fugoso and Hizon, Fugoso and Gomez, Lukban and Rizal, Lukban and Hizon, Lukban and Gomez, Rizal and Hizon, Rizal and Burgos, Hizon and Burgos, Hizon and Gomez, Burgos and Gomez are all significantly different. To know what causes the differences among centers, regression analysis was used wherein the independent variables are the (1) number of students served, (2) number of activities implemented, (3) number of types of disabilities catered and (4) the amount of sponsorship fund received; the dependent variable is the percentage goal achievement. As a result, it has been proven that the above-mentioned independent variables are insignificant predictors of the dependent variable. Thus, it can be deduced that significant differences exist due to variations in the prioritization and fund management.

Subsequent to the comparative analysis, a goal programming model was formulated given the following constraints: Budget Constraint, Student Development Program Weight Contribution Constraint, Percentage Goal Achievement Constraint, Expense Constraint, Activity Priority Constraint and Population Priority Constraint. With the aid of Lingo 13.0 software, the following results were generated: A. Albert can be optimized by 8.07%, Fugoso can be optimized by 30.078%, J. Lukban can be optimized by 30.08%, J. Rizal can be optimized by 22.36%, M. Hizon can be optimized by 28.93%, P. Burgos can be optimized by 33.42% and P. Gomez can be optimized by 19.75%. This would mean that the current allocations for the aforementioned SPED centers were not optimally aligned with the organizational goal and objectives of the central SPED unit as opportunities for improvement were generated.

From the formulated model, a post optimal analysis was conducted wherein the researcher identified the critical variables that would result to a significant penalty in the objective function once it was introduced again. It is evident that all of the critical variables are part of the Student Development Program Weight Contribution Constraint. It can be inferred that the aforementioned constraint takes control of the model in view of the fact that this constraint limits the other goal constraints that are subsequent to it from being satisfied as seen during the model validation. Also, any changes to the variables affiliated to the abovementioned constraint will result to a significant increase in the objective function.

Moreover, a Lingo code was created and directly linked to MS Access to allow intended users to run the model and generate results of their own. This allows ease of use and serves as a tool to make every financial decision simple, straight-forward and trouble-free, yet ensuring that each decision is aligned with the organizational goal and objectives of the central SPED unit.

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Biographies

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