

Application of Integer Linear Programming Techniques in Staff Training and Development Programmes in Financial Institution: A case study of Central Bank of Nigeria

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Abstract

Face recognition is the identification of humans by the unique characteristics of their Faces. Face recognition technology is the least intrusive and fastest bio-metric technology. It works with the most obvious individual identifier, which is the human face. This research aims at providing a binary encoded format for extracting features from human faces using Huffman encoding and the Mahalanobis distance for distance similarity measures and face recognition purposes. The accuracy of the system was measured based on image size variation using the true positive, true negative, false positive and false negative statistical metrics.

Keywords: Directorate, Training, Optimization, Integer linear programming, linear programming.

1. Introduction

Decision-making is a vital aspect in the context of complex managerial tasks. The effective functioning of an organization depends to a large extent on making right decisions; whereas wrong decisions can have far-reaching consequences[1]. Tentative decisions cannot be made on a trial and-error basis, intuition, guesswork or personal judgment. Hence, an understanding of the applicability of scientific or quantitative techniques is of fundamental importance to decision-makers [2].

The practice of optimization techniques in this respect provides a scientific approach to make effective and appropriate decisions[1].

Further research showed that staff training and skills acquisition programs can be presented as a two-stage mixed integer programming [3]. In the first stage of this approach, a trade was made between the training costs and the resulting cheaper workforce schedule. In the second stage, an optimal and feasible training schedule in order to obtain the desired skill mix with minimal costs was achieved.

There are five Directorates in the Central Bank of Nigeria Abuja, namely, (i) Corporate Services Directorate, (ii) Economic Policy Directorate, (iii) Financial System Stability Directorate, (iv) Operations Directorate and (v) Governors' Directorate. These five Directorates comprise of seven, five, five, five and six departments/institutes respectively. A total of 958 members of directorates (Directors, Deputy Directors, Assistant Directors, Senior Managers, Managers Deputy Managers and Assistant Managers) are serving in various departments/institutes functioning under the above mentioned five Directorates.

2.0 Materials and Method

2.1 Methodology

In this research work, quantitative research methodology was adopted. In order to pursue the objective of this work, data was collected; classified and mathematical models were formulated for each of the five Directorates of the CBN. Prospectus (2014/2015) of the Central Bank of Nigeria was referred to for the collection of the data. The data collected included the number of Directorate members (Directors, Deputy Directors, Assistant Directors, Senior Managers, Managers, Deputy Managers and Assistant Managers) serving in various departments/institutes under each of the five Directorate.

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Decision Variables: $X_1, X_2, X_3, X_4, X_5, X_6$ and X_7 are respectively used to represent Directors, Deputy Directors, Assistant Directors, Senior Managers, Managers, Managers, Deputy Managers and Assistant Managers in this research work **Objective Function:** In any business/organization, the main aim is to minimize cost and in this case, it is a minimization problem because the cost of training of staff has to be minimized. Therefore, the objective function is given by:

Minimize:

$$Z = C_1X_1 + C_2X_2 + C_3X_3 + C_4X_4 + C_5X_5 + C_6X_6 + C_7X_7 \quad (1)$$

where $C_1, C_2, C_3, C_4, C_5, C_6$ and C_7 are average costs associated with training of Directors, Deputy Directors, Assistant Directors, Senior Managers, Managers, Managers, Deputy Managers and Assistant Managers respectively.

Constraints: The constraint for this study is the time available for training as the program is in-service training.

2.2 Model Assumptions

The followings are the underlined assumptions for the models in this research work

- (a) The training program continues for 20 days.
- (b) The cost of training a Director is ₦ 200,000
- (c) The cost of training a Deputy Director is ₦ 150,000
- (d) The cost of training an Assistant Director is 120,000
- (e) The cost of training a Senior Manager is ₦ 100,000
- (f) The cost of training a Manager is ₦ 80,000
- (g) The cost of training a Deputy Manager is ₦ 70,000
- (h) The cost of training an Assistant Manager is ₦ 60,000
- (i) The decision variables are linearly related with the data of each Departmental member
- (j) The objective function is also having a linear relationship with the decision variables.

2.3 Tools and Techniques

Integer Linear Programming (ILP) technique was used to formulate the mathematical models which were solved using Linear Programming Solver.

2.4 Data presentation

The data used for this research work is secondary data obtained from Prospectus (20104/2015) of the CBN. The data (given in the tables below) present the number of Directors, Deputy Directors, Assistant Directors Senior Managers, Managers and Contract Staff serving in various departments/ institutes of the CBN.

Table1: table of data for the five Directorates of the CBN

Directorate	Departments	Director (X_1)	Dpty. Director (X_2)	Asst. Director (X_3)	Snr. Manager (X_4)	Manager (X_5)	Dpty Manager (X_6)	Asst. Manager (X_7)
Corporate Services	Corporate Communication	1	5	6	10	5	5	8
	Finance	1	3	8	8	3	9	12
	Human Resources	1	6	5	5	6	7	10
	Legal Services	1	4	5	4	4	8	15
	Medical Services	1	2	4	6	6	8	10
	Procurement & Support	1	2	7	8	5	8	10
Economic Policy	Departments	X_1	X_2	X_3	X_4	X_5	X_6	X_7
	Financial Market	1	4	9	12	11	4	6
	Monetary Policy	1	5	7	7	6	5	10
	Research	1	3	5	6	8	8	12
	Statistics	1	6	8	4	8	5	15
	Trade & Exchange	1	7	4	6	5	3	8
Financial System & Stability	Departments	X_1	X_2	X_3	X_4	X_5	X_6	X_7
	Banking supervision	1	8	12	10	9	6	5
	Consumer protection	1	6	5	7	8	10	5
	Financial policy & Regulation	1	4	4	10	6	6	5
	Other Financial Institution Supervision	1	9	8	6	12	14	8

Departments	X ₁	X ₂	X ₃	X ₄	X ₅	X ₆	X ₇
Banking & Payment System	1	6	5	6	13	5	4
Branch Operations	1	3	5	10	8	9	5
Currency Operations	1	7	6	8	9	7	3
Information Technology	1	5	4	9	10	8	8
Reserve Management	1	4	8	9	7	8	3

Departments	X ₁	X ₂	X ₃	X ₄	X ₅	X ₆	X ₇
Corporate Secretariat	1	2	8	5	11	5	8
Risk Management	1	4	6	5	8	7	11
Development Finance	1	6	4	7	10	6	10
Internal Audit	1	5	8	9	12	9	8
Strategy Management	1	3	10	6	7	10	8

MODELS FORMULATION

The model for Corporate Services Directorate is:

$$\begin{aligned}
 & \text{Maximize } Z = 20000X_1 + 150000X_2 + 120000X_3 + 100000X_4 + 80000X_5 + 70000X_6 + 60000X_7 \\
 & \text{Subject to:} \\
 & -6X_3 + 10X_4 + 5X_5 + 5X_6 + 8X_7 \geq 20 \text{ (Corporate Communication Department)} \\
 & -8X_3 + 8X_4 + 3X_5 + 9X_6 + 12X_7 \geq 20 \text{ (Department of Finance)} \\
 & -5X_3 + 5X_4 + 6X_5 + 7X_6 + 10X_7 \geq 20 \text{ (Human Resources Department)} \\
 & -5X_3 + 4X_4 + 4X_5 + 8X_6 + 15X_7 \geq 20 \text{ (Department of Legal Services)} \\
 & -2X_3 - 4X_4 + 6X_5 + 6X_6 + 8X_7 \geq 20 \text{ (Department of Medical Services)} \\
 & -2X_3 - 7X_4 + 8X_5 + 5X_6 + 10X_7 \geq 20 \text{ (Department of Procurement & Support)} \\
 & X_1, X_2, X_3, X_4, X_5, X_6, X_7 \geq 0 \text{ and integers}
 \end{aligned}
 \tag{2}$$

The model for Economic Policy Directorate is:

$$\begin{aligned}
 & \text{Maximize } Z = 20000X_1 + 150000X_2 + 120000X_3 + 100000X_4 + 80000X_5 + 70000X_6 + 60000X_7 \\
 & \text{Subject to:} \\
 & -9X_3 + 12X_4 + 11X_5 + 4X_6 + 6X_7 \geq 20 \text{ (Department of Financial Market)} \\
 & -X_3 + 7X_4 + 7X_5 + 6X_6 + 10X_7 \geq 20 \text{ (Department of Monetary Policy)} \\
 & -X_3 - 5X_4 + 6X_5 + 8X_6 + 8X_7 \geq 20 \text{ (Department of Research)} \\
 & -6X_3 - 8X_4 + 4X_5 + 8X_6 + 15X_7 \geq 20 \text{ (Department of Statistics)} \\
 & -7X_3 + 4X_4 + 6X_5 + 5X_6 + 8X_7 \geq 20 \text{ (Department of Trade and Exchange)} \\
 & X_1, X_2, X_3, X_4, X_5, X_6, X_7 \geq 0 \text{ and integers}
 \end{aligned}
 \tag{3}$$

The model for Financial System and stability Directorate

$$\begin{aligned}
 & \text{Maximize } Z = 20000X_1 + 150000X_2 + 120000X_3 + 100000X_4 + 80000X_5 + 70000X_6 + 60000X_7 \\
 & \text{Subject to:} \\
 & -12X_3 + 10X_4 + 9X_5 + 6X_6 + 5X_7 \geq 20 \text{ (Department of Banking Supervision)} \\
 & -6X_3 + 5X_4 + 7X_5 + 8X_6 + 10X_7 \geq 20 \text{ (Department of Consumer Protection)} \\
 & -6X_3 + 4X_4 + 10X_5 + 6X_6 + 5X_7 \geq 20 \text{ (Dept. of Financial Policy & Regulation)} \\
 & -8X_3 + 8X_4 + 6X_5 + 12X_6 + 14X_7 \geq 20 \text{ (Dept. of other Financial Institution Supervision)} \\
 & X_1, X_2, X_3, X_4, X_5, X_6, X_7 \geq 0 \text{ and integers}
 \end{aligned}
 \tag{4}$$

3.4 The Model for Operations Directorate:

Minimize:

$$Z = 200000X_1 + 150000X_2 + 120000X_3 + 100000X_4 + 80000X_5 + 70000X_6 + 60000X_7$$

Subject to:

$$X_1 + 6X_2 + 5X_3 + 6X_4 + 13X_5 + 5X_6 + 4X_7 \geq 20 \text{ (Dept. of Banking and Payment System)}$$

$$X_1 + 3X_2 + 5X_3 + 10X_4 + 8X_5 + 9X_6 + 5X_7 \geq 20 \text{ (Dept. of Branch Operations)}$$

$$X_1 + 7X_2 + 6X_3 + 8X_4 + 9X_5 + 7X_6 + 3X_7 \geq 20 \text{ (Department of Currency Operations)}$$

$$X_1 + 5X_2 + 4X_3 + 9X_4 + 10X_5 + 8X_6 + 8X_7 \geq 20 \text{ (Dept. of Information Technology)}$$

$$X_1 + 4X_2 + 8X_3 + 9X_4 + 7X_5 + 8X_6 + 3X_7 \geq 20 \text{ (Department of Reserve Management)}$$

$$X_1, X_2, X_3, X_4, X_5, X_6, X_7 \geq 0 \text{ and integers}$$

(5)

3.5 The model for Governors' Directorate is:

Minimize:

$$Z = 200000X_1 + 150000X_2 + 120000X_3 + 100000X_4 + 80000X_5 + 70000X_6 + 60000X_7$$

Subject to:

$$X_1 - 2X_2 + 8X_3 + 5X_4 + 11X_5 + 5X_6 + 8X_7 \geq 20 \text{ (Department of Corporate Secretariat)}$$

$$X_1 - 4X_2 - 6X_3 + 5X_4 + 8X_5 - 7X_6 + 11X_7 \geq 20 \text{ (Department of Governors)}$$

$$X_1 - 3X_2 - 4X_3 - 7X_4 + 9X_5 - 8X_6 - 6X_7 \geq 20 \text{ (Department of Risk Management)}$$

$$X_1 - 6X_2 - 5X_3 - 4X_4 - 10X_5 + 6X_6 + 10X_7 \geq 20 \text{ (Development Finance Department)}$$

$$X_1 - 5X_2 - 8X_3 - 9X_4 - 12X_5 - 9X_6 + 8X_7 \geq 20 \text{ (Internal Audit Department)}$$

$$X_1 - 3X_2 + 10X_3 - 6X_4 + 7X_5 + 10X_6 + 8X_7 \geq 20 \text{ (Strategy Management Department)}$$

$$X_1, X_2, X_3, X_4, X_5, X_6, X_7 \geq 0 \text{ and integers}$$

(6)

4.0 RESULTS AND DISCUSSION

The integer linear programming models formulated above were solved using Linear Programming Solver and the summary of the results obtained are given in the table2 below:

Table2: Table of Summary

Name of Directorate	Director (X ₁)	Deputy Director (X ₂)	Assistant Director (X ₃)	Senior Manager (X ₄)	Manager (X ₅)	Deputy Manager (X ₆)	Assistant Manager (X ₇)	Cost of Training (₦)
Corporate Services	0	0	1	0	0	0	3	300000
Economic Policy	0	0	0	0	1	0	2	200000
Financial System & Stability	0	0	0	1	0	1	1	230000
Operations	0	0	1	0	1	2	0	340000
Governors	0	0	0	0	1	1	1	210000

4.1 Analysis and Discussion of result of the Corporate Service Directorate

$$X_1 = 0, X_2 = 0, X_3=0, X_4=0, X_5=0, X_6=0, X_7 = 3, Z= ₦ 300000$$

The above results show that from the Directorate of Corporate Service, none of Director, Deputy Directors, Senior Managers, Managers or Deputy Managers should be sent for the training program; only one Assistant Director and three Assistant Managers should be selected from this Directorate for the training program and this will cost ₦300000.

4.2 Analysis and Discussion of result of the Economic Policy Directorate

$$X_1 = 0, X_2 = 0, X_3=0, X_4=0, X_5=1, X_6=0, X_7 = 2, Z= ₦ 200000$$

From the Directorate of Economic Policy, none of Director, Deputy Directors, Assistant Directors, Senior Managers and Deputy Managers should be sent for the training program: only one Manager and two Assistant Managers must be selected for the training program and this will cost ₦200000.

4.3 Analysis and Discussion of result of the Financial System and Stability Directorate

$$X_1 = 0, X_2 = 0, X_3 = 0, X_4 = 2, X_5 = 0, X_6 = 2, X_7 = 0, Z = \text{₦ } 230000$$

From the Directorate of Financial System and Stability, it is shown that none of Director, Deputy Directors, Assistant Directors and Managers should be sent for the training program; only one Senior Managers one Deputy Manager and one Assistant Manager should be selected for the program and this will lead to the training cost of ₦230000.

4.4 Analysis and Discussion of result of the Operations Directorate

$$X_1 = 0, X_2 = 0, X_3 = 1, X_4 = 0, X_5 = 1, X_6 = 2, X_7 = 0, Z = \text{₦ } 340000$$

From the Directorate of Operations, none of Director, Deputy Directors and Senior Managers should be sent for the program; only Assistant Director, one Manager and two Deputy Managers must be selected for the training program and this selection will cost ₦340000.

4.5 Analysis and Discussion of result of the Governor's Directorate

$$X_1 = 0, X_2 = 0, X_3 = 0, X_4 = 0, X_5 = 1, X_6 = 1, X_7 = 1, Z = \text{₦ } 210000$$

Finally, from the Governor's Directorate, none of Director, Deputy Directors, Assistant Directors and Senior Managers should be sent for the training; only one Manager, one Deputy Manager and one Assistant Manager must be selected for the faculty training program and this will lead to a cost of ₦210000

5.0 Conclusion

The objective of this work is to determine an optimal strategy for Directorate training in CBN which minimizes the cost of training. The study uses seven decision variables: $X_1, X_2, X_3, X_4, X_5, X_6,$ and X_7 which respectively denote the number of Directors, Deputy Directors, Assistant Directors, Senior Managers, Managers, Managers, Deputy Managers and Assistant Managers to be selected for the Directorate training program. Integer linear programming (ILP) technique is used to formulate the mathematical models which are solved using Linear Programming Solver. The results obtained from these models provide the optimum number of Directors, Deputy Directors, Assistant Directors, Senior Managers, Managers, Managers, Deputy Managers and Assistant Managers to be selected for the training program from each of the five directorate of the CBN, along with the cost incurred owing to their training.

Managers to be selected for the Directorate training program. Integer linear programming (ILP) technique is used to formulate the mathematical models which are solved using Linear Programming Solver. The results obtained from these models provide the optimum number of Directors, Deputy Directors, Assistant Directors, Senior Managers, Managers, Managers, Deputy Managers and Assistant Managers to be selected for the training program from each of the five directorate of the CBN, along with the cost incurred owing to their training.

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