Research Paper
Impact Factor: 6.089
Peer Reviewed Monthly Journal
www.ijmdrr.com

IJMDRR
E- ISSN –2395-1885
ISSN -2395-1877

ANALYSIS ON IMPORTANCE OF LINEAR PROGRAMING MODEL (LPM) IN ASSET MANAGEMENT OF BANKS: A CASE STUDY ON SBI BANK

K. Ram Prasad* Prof.B.Krishna Reddy**
**Ph.D. Research Scholar,Sri Krishnadevaraya Institute of Management,*
Sri Krishnadevaraya University,Ananthapuramu, Andhra Pradesh State.
***Former Dean & Retired Professor,Sri Krishnadevaraya Institute of Management,*
Sri Krishnadevaraya University, Ananthapuramu, Andhra Pradesh State.

Abstract
Management of Assets is an important function in banking sector, the proper management of assets in bank shown its impact on profitability and overall performance of bank. The efficient management of assets in bank is influenced by the liquidity, operation and market risk. Linear Programing is an important statistical technique used in determining the optimum solution for production and operation process. The linear programing model is often used in banking sector to determine the efficiency of banks in managing the different forms of risks associated to banks. The current paper particularly analyzes the importance of linear programing in managing the assets of banks.

Keywords: Bank, Assets, Linear Programing, Profit Liquidity, Risk and Market.

1. Introduction to Management of Assets in Banking Sector

Asset management in the Indian banking system refers to the practices and strategies implemented by banks to effectively manage their assets, which primarily include loans and investments. The management of assets is crucial for banks to optimize profitability, minimize risks, and ensure regulatory compliance. The below are some key aspects of asset management in the Indian banking system.

Loan Portfolio Management

Banks in India carefully manage their loan portfolios to balance risk and return. This involves assessing borrower creditworthiness, setting appropriate interest rates, defining loan terms and conditions, and monitoring loan performance. Banks use credit risk assessment tools, such as credit scoring models, to evaluate borrowers' ability to repay loans and to determine appropriate risk premiums.

Risk Management

Banks employ various risk management techniques to mitigate potential risks associated with their asset portfolios. This includes assessing and managing credit risk, market risk, liquidity risk, and operational risk. Risk management practices in Indian banks are guided by the Reserve Bank of India (RBI) regulations and guidelines.

Non-Performing Asset (NPA) Management

Banks actively monitor and address non-performing assets, which are loans that have defaulted or are at risk of default. The RBI sets guidelines for the classification and provisioning of NPAs, and banks are required to maintain adequate provisions to cover potential losses from these assets. Banks implement measures like loan restructuring, asset recovery, and write-offs to address NPAs and minimize their impact on profitability.

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Investment Management
Banks invest their surplus funds in various instruments, such as government securities, bonds, corporate debt, and equity shares. These investments generate income for banks and help diversify their asset portfolios. The management of investments involves assessing market conditions, monitoring investment performance, and ensuring compliance with regulatory guidelines.

Regulatory Compliance
Banks in India must comply with various regulations and guidelines issued by the RBI and other regulatory authorities. These regulations govern capital adequacy, asset classification, provisioning norms, exposure limits, and risk management practices. Effective asset management requires banks to stay updated with the latest regulatory developments and ensure adherence to the prescribed guidelines.

Technology Adoption
Indian banks are increasingly leveraging technology to enhance their asset management practices. This includes implementing robust risk management systems, using data analytics for credit risk assessment, employing automated loan monitoring tools, and adopting advanced portfolio management solutions. Technology-driven asset management enables banks to improve efficiency, accuracy, and decision-making.

Overall, asset management in the Indian banking system is guided by regulatory frameworks, risk management practices, and technology adoption to maintain a sound and stable financial system. The RBI plays a pivotal role in setting guidelines and monitoring the asset quality of banks to safeguard depositor interests and maintain the health of the banking sector.

2. Importance of Linear Programing in Banking Sector

Linear programming (LP) models can be applied in the banking sector to optimize various decision-making processes and resource allocation. Here are a few examples of how linear programming can be used in the banking sector:

Portfolio Optimization
Banks often manage investment portfolios on behalf of their clients. Linear programming can be used to optimize the allocation of funds across different investment options while considering risk and return objectives. The objective could be to maximize the return on investment given a certain level of risk or to minimize the risk while achieving a target return.

Cash Management
Banks need to efficiently manage their cash flow to meet withdrawal demands, maintain liquidity, and minimize the costs associated with idle cash or borrowing. Linear programming models can be used to determine the optimal cash inflow and outflow strategies, including the timing and amounts of deposits, withdrawals, and interbank borrowing or lending.

Loan Portfolio Optimization
Banks offer various types of loans to borrowers. Linear programming can assist in optimizing the loan portfolio by determining the allocation of available funds across different loan categories, such as personal loans, mortgages, business loans, etc. The objective could be to maximize interest income while considering risk exposure and regulatory constraints.

Risk Management

Banks need to manage their risk exposure within acceptable limits. Linear programming can be used to determine the optimal allocation of risk among different assets, such as loans, investments, and derivatives, while considering risk-return trade-offs and regulatory requirements. The objective could be to minimize the overall risk exposure or to achieve a target risk level while maximizing profitability.

These are just a few examples of how linear programming can be applied in the banking sector. The specific application and formulation of the LP model would depend on the objectives, constraints, and data available for each scenario.

3. Linear Programming Model

Linear programming (LP) is a mathematical optimization technique used to find the best possible outcome in a given mathematical model, subject to linear constraints. The objective is to maximize or minimize a linear function of the decision variables, while satisfying a set of linear equality or inequality constraints.

A general linear programming model can be represented as follows:

Objective function: Maximize (or minimize) $Z = c_1x_1 + c_2x_2 + ... + cnxn$

Subject to: $a_{11}x_1 + a_{12}x_2 + ... + a_1nxn \leq b_1$

$a_{21}x_1 + a_{22}x_2 + ... + a_2nxn \leq b_2$

... .

$am_1x_1 + am_2x_2 + ... + amnxn \leq bm$

where:

Z represents the objective function to be optimized.

$c_1, c_2, ..., cn$ represent the coefficients of the decision variables $x_1, x_2, ..., xn$ in the objective function.

$a_{11}, a_{12}, ..., a_1n, b_1$ represent the coefficients and the right-hand side of the first constraint.

$a_{21}, a_{22}, ..., a_2n, b_2$ represent the coefficients and the right-hand side of the second constraint.

$am_1, am_2, ..., amn, bm$ represent the coefficients and the right-hand side of the mth constraint.

$x_1, x_2, ..., xn$ represent the decision variables, which can take any real values.

The constraints in the model represent the limitations or requirements that must be satisfied. These constraints can be in the form of capacity constraints, resource constraints, demand constraints, etc.The objective function represents the quantity to be optimized, such as profit maximization, cost minimization, or resource utilization maximization.

4. Literature Review

Zopounidis (2002), presented a goal programming model of asset liability management for Greek commercial banks. Their considered goals were maximization of returns, reduced risk, the maintenance of liquidity and solvency at a desirable level, as well as the expansion of deposits and loans.

Joly (2012), used linear programming in the oil sector to find optimal production process towards the maximum profit. He developed the linear programming model by considering the machine and labour capacity in production unit and design the model for maximizing the production capacity.

Tunjo and Zoran (2012), used Taylor's formula to formulate the linearization of fractional functions before applying it in goal programming technique to find the optimal solution for the company's financial structure. The optimal solution attained linear model will have helped in maximize the profits of banks in future.

Mehrzad and Hadi (2013), developed a mathematical model to find optimum management of assets, liabilities and equity for Mellat Bank. They first determined the priorities of goals using analytical hierarchy process (AHP) before optimizing it using goal programming. The determination of priorities in ALM i.e., Asset Liability Management helps the banks to minimize the risk.

Ekezie and Onuohac (2013),also formulated the goal programming algorithm using the weight method and pre-emptive method for budget allocation of higher learning institutions. The budget allocation technique developed by Linear Programing model is helps the institutions to identify the priorities of and allotted the budget based on the priority ranking model using linear programing.

5. Objectives

1. To Study the importance of Linear Programing in Banking Sector
2. To analyse the impact of linear programing in managing the assets of bank.
3. To examine the performance of bank assets using the linear programing model.

6. Data Analysis & Discussion

The present analysis carried out to determine the optimal solution for maximizing the assets of banks. The present study considered the assets of last five financial years of SBI (State Bank of India) for the period starting from 2018-19 to 2022-23.

The below is the maximize equation developed based on the average assets of SBI bank during the said five financial years.

$Z_{(MAX)} = 0.31X_1 + 4.16X_2 + 0.04X_3 + 0.34X_4$

Subjected to the constraints

$X_1 + X_2 \geq 4.47$
$X_3 + X_4 \geq 0.38$
$X_2 + X_3 + X_4 \leq 4.54$
$X_1 + X_4 \leq 0.65$ Here

X_1represents the Amount of total Cash Balances of bank (in Millions of Rupees)
X_2 represents the Amount of total Investments & Advances of bank (in Millions of Rupees)
X_1represents the Amount of total Fixed Assets of bank (in Millions of Rupees)
X_1represents the Amount of total Other Assets of bank (in Millions of Rupees)

By considering the above values and constraints the maximum value of total Assets of banks is determined using linear programming model in MS – Excel and the below are the results obtained in linear programing model.

$X_1 = 0.65$, $X_2 = 3.82$, $X_3 = 0.38$ and $X_4 = 0$ Then

The values of $Z_{(max)}$ is obtained as 16.11 (Millions Rupees) approximately here $Z_{(max)}$ represents the overall maximization of assets during the period considered in present study.

Analysis on Answer Report Attained in Linear Programming Model

Table-1: Variable Values

Name	Original Value	Final Value (Millions)
solution X1	0	0.65
solution X2	0	3.82
solution X3	0	0.38
solution X4	0	0

Interpretation

The table above demonstrated the values of variables defined in objective function, it is observed the values of variables are identified as 0.65 for X_1, X_2 is 3.82, X3 is 0.38 Million and X_4 is obtained as 0. Here the variables X_1, X_2, X3 and X_4 represents the overall cash balances, Investments & Advances, Fixed Assets and Other Assets of Bank in Million. The highest value is attained by Investments & Advances.

Table-2: Constraint Values

Name	Cell Value	Status	Slack
Constraint1	4.47	Binding	0
Constraint2	0.38	Binding	0
Constraint3	4.2	Not Binding	0.34
Constraint4	0.65	Binding	0

Interpretation

The table above explains the characteristics and values of 'four constraints and their associated slack variables determined in linear programming model. It is noticed from the table the constraints three slack variable achieved the numeric-value 0.34 and remaining three constraints slack variables are obtained as zero in linear programing. The cell values of constraint are found different from one to another. The maximum i.e., 4.47 is associated to constraint one and the minimum i.e., 0.38 is obtained by constraint two.

Analysis on Sensitivity Report of Linear Programming

Table-3: Sensitivity values of Variables in LP

Variable	Final Value	Reduced Cost	Objective Coefficient	Allowable Increase	Allowable Decrease
solution X1	0.65	0	1	1E+30	1
solution X2	3.82	0	0	0	1E+30
solution X3	0.38	0	0	0	1
solution X4	0	-1	0	1	1E+30

Interpretation

The table above demonstrates the sensitivity values of variables considered in linear programming, the final values of four constraints attained in linear model based on the objective function is 0.65, 3.82, 0.38 and 0 respectively. The objective coefficient of first content is noticed as '1' and remaining three constraints objective coefficients are obtained as '0'.

Table-4: Sensitivity values of Constraints in LP

Name	Final Value	Shadow Price	Constraint RHS	Allowable Increase	Allowable Decrease
Constraint1 LHS	4.47	0	4.47	0.34	3.82
Constraint2 LHS	0.38	0	0.38	0.34	0.38
Constraint3 LHS	4.2	0	4.54	1E+30	0.34
Constraint4 LHS	0.65	1	0.65	3.82	0.34

Interpretation

The table above demonstrated the sensitivity values of constraints in linear programing model executed on assets of SBI bank, it is noticed from the table the LHS (Left Hand Side) values of four constraints is attained the numeric-values 4.74, 0.38, 4.2 and 0.65 and RHS (Right Hand Side) constraint values of 'simplex linear programming model' is attained the numeric-values 4.47, 0.38, 4.54 and 0.65. The allowable increase/decrease in values of constraints is varied between 0.34 and 3.82.

7. Conclusion

The present paper explained the importance of Linear Programming Model in Management of Assets in banking sector. The study found linear programing model particularly simplex method is very useful to determine the importance of different variables i.e., assets in management of assets. This model helpful to estimate the optimum value i.e., maximum value of total assets banks by considering the different asset disclosed in balance sheet. The present study found the optimal values of assets of SBI during the last five financial years the values attained in 'simple linear model' are cash balances 0.65 million, investment & advances 3.82 million, fixed assets 0.38 million and other assets attained as zero to achieved the maximum overall total assets value 16.11 million. It clearly concluded from the result of linear programing the bank should concentrate more on investments & advance, cash balances and fixed assets to increase the overall assets of bank.

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