ISSN (Online) 2456 -1304

International Journal of Science, Engineering and Management (IJSEM)

Volume 12, Issue 04, April 2025

A Methodological Framework of AI in Banking Operational Optimization, a Focus on PR

[1] Reza G. Hamzaee, [2] Maryam Salimi

[1] Economics, Missouri Western State University, and RMD Hamzaee Econometrics International Consultants, Overland Park, U.S.A

[2] Infographics & Journalism, Soore University

* Corresponding Author's Email: [1] hamzaee@missouriwestern.edu, [2] salimi1356@gmail.com

Abstract*— Financial industries have already been transformed into some limited artificial intelligence groundwork, like many other industries. Yet, it would be interesting - and perhaps necessary - to explore how AI can be best applied in an articulated task of determining the extent to which AI should optimally cover the fundamentals of, e.g., banking operations alongside an effective public relations strategy. We may decompose the deterministic functional formulas through a linear programming methodology to derive the production possibilities curve (PPC) for asset portfolio building, on the one hand, and a clearly defined set of utility indifference functions, representing a bank's customers' preferences and/or what a massive data-based AI- implied functions would recommend. In that structural approach, the potential for all available practitioners-researchers' advice stressing on avoidance of too much reliance on AI and a critical loss of control by the chartered decision makers, would be considered. Both or either AI and/or managers would have the applicable control, as seen "most preferrable" to the management. More recommendations will dynamically arise for optimal decision-making, on – among the most fundamental variables - trust-capital accumulation through an optimal PR.

***Index Terms*— Artificial intelligent, banking, operational optimization, public relations, linear programming.**

I. INTRODUCTION AND THE CITED RESEARCH

It is possible to run a rather small business without worrying about all the available advanced technological leverages available to organizations. Yet, economics of the size would necessitate the same golden rules and resource allocation formulas (inclusive of AI tech), in which not only the optimal size, but the ratios of marginal revenue product - across all the needed resources - over their corresponding marginal resource expense (cost) must be as closely equal as possible, as formulated below:

$$\frac{MRE_{i,t}}{MRP_{i,t}} = \frac{MRE_{i+1,t}}{MRP_{i+1,t}} \quad \text{for all the k resources to be used by the bank,}$$

and i= 1, 2,...., k-1 (1) $MRE_{i,t}$ = Marginal Reource Expense of the ith resource in period t (representing maginal cost)

$MRP_{i,t}$ = Marginal Revenue Product of the ith resource in period t (representing marginnal benefit)

According to Hosanagar, K. and Krishnan, R. (Spring 2024), having more user data to work with, would facilitate the most popular Large Language Models (LLM), which have demonstrated to have attracted even more users, to make faster progress than smaller ones. Also, they emphasized the access to quantity and quality of data in their specific domain as a comparative advantage in creating specialized models.

AI has been contributing to the enhancement and accuracy of customer satisfaction, operational efficiency, public relations, credit scoring, fraud detection, and customer service, as highlighted by Narang, Ashima, et al (March 2024).

Also, Suprit Kumar Pattanayak (2021), focusing on banking operational efficiency, analyzed how AI in learning through automation would contribute to the banking efficiency, while incorporating issues such as skills substitution, security aspects of data and the relevant technological innovation that would appropriately accompany the support for more efficiency and productivity.

However, while Castro, Jian, and Martin (Winter 2025) propose that despite all the efficiency and productivity advantages of Generative AI's Large Language Models (LLMs), the thoughtful and dynamic leadership concerns would involve the loss of originality and innovative potentials in employees, which could lead to some diminishing human capital. Hence, there must be some optimal mixtures of more active human decision making alongside some carefully selected Gen AI's LLMs' infusion. In this research, our proposed model would offer the needed space for both machine-learning–based (automatic) decision making, as well as an ultimate role for bank investment managers, through a simultaneous incorporation of their customers' collective utility maximization (or optimization) functions.

Also, we are finding some serious issues of two major kinds of workflow bottlenecks in industries, such as airlines, as proposed by Karim, Lee, and Hoen-Weiss (Winter 2025), including the centralization and complexity bottlenecks. We see how AI would come to the rescue, when over-dependence of some production processes on other phases would create detrimental bottlenecks. This perspective on the workflow efficiency could also involve the necessity of an optimal

ISSN (Online) 2456 -1304

International Journal of Science, Engineering and Management (IJSEM)

Volume 12, Issue 04, April 2025

Public Relations (PR) platform, inclusive of the companies' domestic relations. We are proposing that optimal utilization of a Public Relations platform as a major form of productive capital, PR, itself, is significantly critical in the enhancement of production as well as sales revenues.

On AI and banking, in their "Operational Research and Artificial Intelligence Methods in Banking," Doumpos, Michalis, et al. (2023) offered an OR-AI based methodological – analytical review of bank efficiency, risk, performance, mergers and acquisitions, regulations, customer relations, and technology as applied to the banking industry.

In two earlier published studies, we offered AI modeling to be applied to optimal economic policy as well as detection of fraud, and accordingly, a global survey-based formulation of an applicable anti-fraud policy to be implemented in business organizations and in an economy at large (Hamzaee R., & Salimi, M., 2023). Secondly, and separately we modeled AI-incorporated macroeconomic framework (2024), in which some data-incorporated implications for AI production, based on the necessary resources were highlighted, such as human capital, one of the ingredients of AI, massive data, labor, inclusive of its all-possible attributes, such as education, personal health, OJT, and human capital.

Some other economists' research works on AI model making, including Atashbar (February 24, 2023), Marwala (2023). Meanwhile, Gries and Naude (2020-2022), in their *Modelling Artificial Intelligence*, studied the effects of AI on income distribution and economic growth. Kerry, C. F. (February 10, 2020) proposed that volume (large data), variety, and velocity of even daily data, encompassing almost everything in the real life, would enhance the credibility of real time analyses.

On the treatment of negative effects of AI, Kerry (February 10, 2020) offered a report on "Protecting privacy in an AI-driven world". He stressed on "three Vs" that would highlight the significance of data: first, volume (larger data) would augment the power and reliability of the needed analyses. Second, variety would facilitate the necessary, though, unexpected new findings and predictability power. Finally, velocity of data and information about almost everything in daily real life would ensure real time analyses.

Yet, Marion, Tucker J.; Srour, Mehdi, et al. (Fall 2024) have suggested that a tripod of improvement of the design workflows, gaining customer perspectives, views, and insights, and appropriate usage of Large Language Models (LLMs) to create user-friendly interfaces, are the experienced three major ways, through which companies have revealed to be using and developing generative AI.

II. DESIGNING OF THE THEORETICAL MODEL

Assuming that AI is a valuable resource to be utilized in an intelligent fashion, we must seriously ensure that condition (1), as expressed above, will be satisfied.

All the bank's feasible combinations of short-term and long-term assets to invest in, would be defined by the following PPC equation, in which the bank's overall investment would be limited by its total liabilities that may be determined by variable amounts of deposits and other forms of bank's liabilities and net worth, as expressed below:

$$(1+ i_{s,t}) \cdot SA_t + (1+ i_{l,t}) \cdot LA_t = TL_t + NW_t \qquad (2-a)$$

$$LA_t = \frac{TL_t + NW_t}{(1+ i_{l,t})} - \frac{(1+ i_{s,t})}{(1+ i_{l,t})} \cdot SA_t \qquad (2-b)$$

$$(1+ i_{s,t}) \cdot SA_t + (1+ i_{l,t}) \cdot LA_t = (1+ i'_{s,t}) \cdot SL_t + (1+ i'_{l,t}) \cdot LL_t + NW_t \qquad (2-c)$$

$$LA_t = [\frac{(1+ i'_{s,t})}{(1+ i_{l,t})} \cdot SL_t + \frac{(1+ i'_{l,t})}{(1+ i_{l,t})} \cdot LL_t + \frac{1}{(1+ i_{l,t})} NW_t] - \frac{(1+ i_{s,t})}{(1+ i_{l,t})} \cdot SA_t \qquad (2\text{-d})$$

where:

$i_{s,t}$ = interest rates on short-term assets, and $i_{l,t}$ = interest rates on long-term assets

$i'_{s,t}$ = interest rates on short-term liabilities, and $i'_{l,t}$ = interest rates on long-term liabilities.

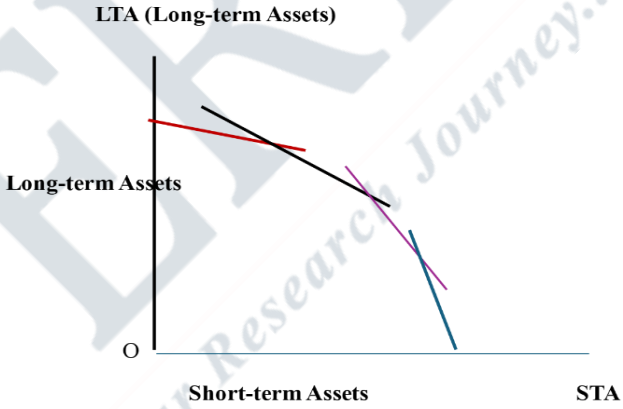

Figure 1. Building a PPC through linear programing model

Banks' assets, including their own net worth (equity), loans of all kinds, various securities, all other issued credit instruments, to be discussed here in the model we've made, plus all physical assets, established public relations (PR), including social capital, and trust (brand-name capital). On the other hand, banks' total liabilities (TL), including all types of customers' deposits, and all other kinds of debt instruments that they sell, are included and discussed in our model.

Banks' resource optimization must be implemented as closely as possible in order to secure neither over-allocation nor under-allocation of their resources to AI. Banks' objectives are summarized in maximizing their net worth (NW), as simply defined below:

$$NW_t = TA_t - TL_t \qquad (3)$$

where, $TL_t = SL_t + LL_t$ (4)

where, SL_t = Total short-term liabilities, and

LL_t = Total long-term liabilities.

ISSN (Online) 2456 -1304

International Journal of Science, Engineering and Management (IJSEM)

Volume 12, Issue 04, April 2025

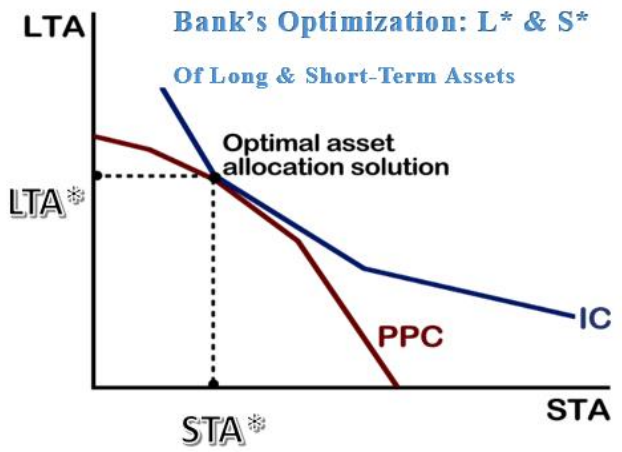

Figure 2. Bank's optimal choice of the long-term (LTA*) and the short-term assets (STA*)

Bank's Strategic Decision:

In an effective understanding of a bank's strategic decisions within a variable interest-rate environment, let's continue to explain the rest of our suggested model:

$SL_t = \sum_1^5 SL_{j,t}$ for all j = 1, 2, ..., l (5)

SL_t = Transactions Deposits [Demand Deposits (DD) + Moey Market Depst Accounts (MMDA)] + self-issued short-term Bankers Acceptaces (SBA) + short-term RPs (SRP)

$LL_t = \sum_1^6 LL_{i',t}$ for all j' = 1,2,...., l' (6)

LL_t = Small Savigs & Time Deposts (SCDs) + Jumbo or Large (LCDs) + Loans from other depository institutions (OL), & all other borrowings (AOB) + bank-issued corporate bonds (BCB) + Term RPs (LRPs), Term Bankers Acceptaces (LBA)

$TA_t = SA_t + LA_t$ (7)

TA_t = Total assts in period t, LA_t = Total long-term assets in period t, SA_t = Total short-term assets in period t,

$NW_t = \sum_1^k SA_{i,t} + \sum_1^{k'} LA_{i',t} - \sum_1^l SL_{j,t} - \sum_1^{l'} LL_{j',t}$ (8)

$SA_t = \sum_1^5 SA_{i,t}$ where i = 1, 2, ..., k, assuming l = 5 (9)

So, $SA_{1,t} = CSL_t$; $SA_{2,t} = BSL_t$; $SA_{3,t} = TB_t$; $SA_{4,t} = CP_t$; $SA_{5,t} = ORP_t$, where:

CSL_t = Consumer short-term loans in period t; BSL_t = Business short-term loans$_t$; TB_t = Treasury Bills$_t$; CP_t =Commercial papers, ORP_t = Overnight Repurchase Agreemets.

$LA_t = \sum_1^6 LA_{i',t}$ (10)

where, i = 1, 2, ..., k', assuming here that k' = 6

So, $LA_{1,t} = CLL_t$; $LA_{2,t} = BLL_t$; $LA_{3,t} = GB_t$; $LA_{4,t} = CB_t$; $LA_{5,t} = MB_t$; $LA_{6,t} = PR_t$, where:

CLL_t = Consumer long-term loans; BLL_t = Business long-term loans; GB_t = Government Bonds; CB_t = High-Grade Corporate Bonds (and bank corporate bonds); MB_t = Municipal Bonds

PR_t = Public Relations platform (capital), which will be quantified.

The bank's strategic decision within an increasing interest-rate environment, as depicted in Figure 3, must be summarized in a larger ratio of short-term versus long-term asset allocation, while the short-term to long-term liabilities would take the opposite direction, which is simply explained below:

$$\frac{SA}{TA} > \frac{LA}{TA}, \text{ and also: } \frac{SL}{TL} < \frac{LL}{TL} \quad (11)$$

More generally, the following will be what banks must do in their optimization of the expected interest rate variations, where a similar exhibition, as made in Figure 3, would apply:

$$\frac{VRA}{TA} > \frac{FRA}{TA}, \text{ and also: } \frac{VRL}{TL} < \frac{FRL}{TL} \quad (12)$$

where, VRA = Variable Rate Assets (loans), FRA = Fixed Rate Assets (loans), VRL = Variable Rate Liabilities (deposits), FRL = Fixed Rate Liabilities (deposits).

The ultimate optimization task would serve the strategic maximization of the bank's net worth, subject to the interest rates expected in period t, as summarized below:

$$\begin{cases} \text{Max } [NW_t = \sum_1^k SA_{i,t} + \sum_1^l LA_{j,t} - \sum_1^{k'} SL_{i',t} - \sum_1^{l'} LL_{j',t}] \\ \text{S.T. } i_t^e = {}_{i_0} + {}_{i_1}.i_{t-1} + {}_{i_2}.i_{t-2} + {}_{i_3}.i_{t-3} + \xi_t \end{cases} \quad (13)$$

ξ_t = stochastic error error term.

In the second line of the above objective function (13), the constraint is on the limits of the expected interest rates, where under an application of the rational expectations theory, one would commonly regress a variable on, e.g., three lags of itself, to have a rather close estimate of the expected value of it prevailing within the current period, t, here, i_t^e.

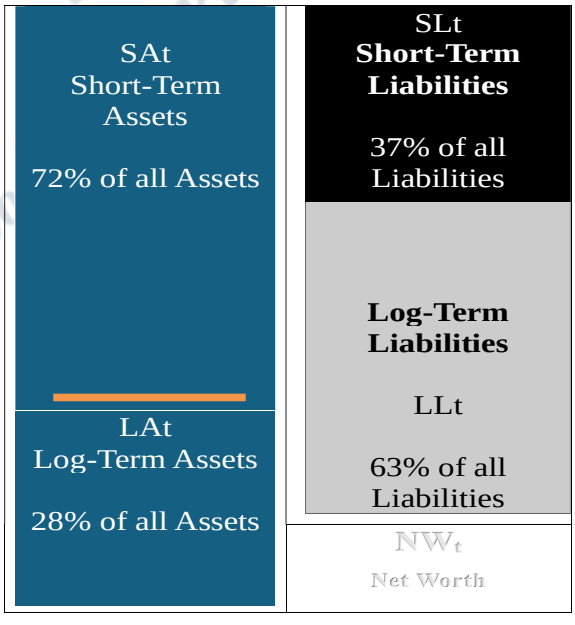

Figure 3. Bank's Strategic Balance-Sheet Structure: When interest rates are expected to rise

All the bank's feasible combinations of short-term and long-term assets to invest in would be defined by the following PPC equation, in which the bank's overall investment would be limited by its total liabilities and net worth, as expressed below:

ISSN (Online) 2456 -1304

International Journal of Science, Engineering and Management (IJSEM)

Volume 12, Issue 04, April 2025

$$i_{s,t} \cdot SA_t + i_{l,t} \cdot LA_t \leq TL_t + NW_t \quad (14)$$

To derive a bank's PPF through the linear programing procedure, several linear functions must be introduced, assuming that all the bank's budget will be used on each of the asset types separately, one by one, represented by a separate linear budget line for each, all of which together would create the investment possibilities, the PPF or PPC:

$i_{i,s,t} \cdot SA_{i,t} + i_{i',l,t} \cdot LA_{i',t} \leq FR_t$ for all i = 1, 2, ..., k; i' = 1, 2, ..., k'.

For example, if there are only 5 of each short-term and long-term assets, then we will have the following linear free reserve restrictions:

$$i_{1,S,t} \cdot SA_{1,t} + i_{1,l,t} \cdot LA_{1,t} \leq FR_t \quad (15)$$

$$i_{2,S,t} \cdot SA_{2,t} + i_{2,l,t} \cdot LA_{2,t} \leq FR_t \quad (16)$$

.....

$$i_{5,t} \cdot SA_{5,t} + i_{5,l,t} \cdot LA_{5,t} \leq FR_t \quad (17)$$

where: $i_{s,t}$ = the curret short term interest rates; $i_{l,t}$ = the curret long term interest rates; FR_t = bank's currennt free reserves for ivestment. Each of the above equations can be re-expressed in the following form:

$$LA_t = \frac{FR_t}{i_{l,t}} - \frac{i_{s,t}}{i_{l,t}} \cdot SA_{i',t} \quad (18)$$

The next function to incorporate into the bank's optimization objective is the utility function, which represents all combinations of, e.g., $20 thousand units of short-term and long-term assets (e.g., banks investment in loans and securities), in which would render the same satisfaction level or utility to the bank's customers, as listed below:

$$U_t = U(SA_t, LA_t) \quad (19)$$

Equation (18) will be only one of the many similarly formulated indifference curves, with a well-defined objective of achieving the highest possible utility level (reflected by the highest obtainable indifference curve), within the bank's PPC (production possibilities curve), as depicted in Figures 2 and 4.

So, once again, all the bank's feasible combinations of short-term and long-term assets to invest in would be defined by the following PPC equation, in which the bank's overall investment would be limited by its total liabilities and net worth, as expressed below:

$$i_{s,t} \cdot SA_t + i_{l,t} \cdot LA_t \leq TL_t + NW_t \quad (14)$$

Needless to say, that banks would always think of their liability restrictions and resources (deposits of various kinds, as an example) as well. In that case they would encounter a PPC alternatively formulated to represent long-term and short-term liabilities (instead of the assets) re-expressed in the following equation:

$$i'_{s,t} \cdot SL_t + i'_{l,t} \cdot LL_t \leq TA_t + NW_t \quad (20)$$

$$LL_t \leq \frac{1}{i'_{l,t}}(TA_t + NW_t) - \frac{i'_{s,t}}{i'_{l,t}} SL_t \quad (21)$$

Also, in a similar re-arrangement of the PCC function, one may choose to derive the following SL_t function

$$SL_t \leq \frac{1}{i'_{s,t}}(TA_t + NW_t) - \frac{i'_{l,t}}{i'_{s,t}} SL_t \quad (22)$$

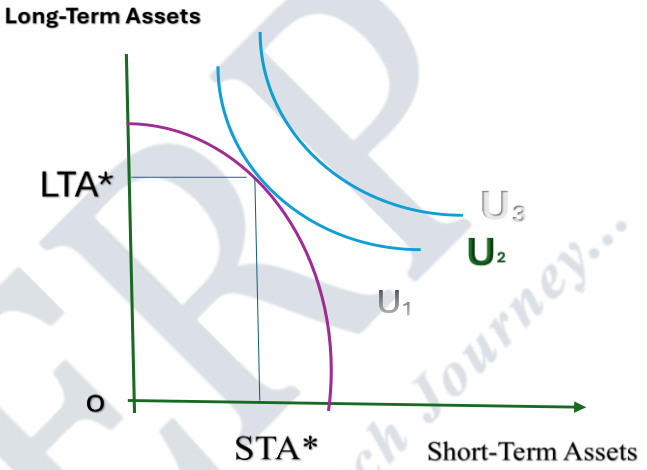

Figure 4. Bank's Optimal Choice of the Long-Term (LTA*) and the Short-Term Assets (STA*)

III. ANALYSIS, SUMMARIES, AND CONCLUSIONS

In this AI model making effort, we have focused on banking operational optimization by first analyzing the main challenging objectives of a modern bank within a variable interest-rate environment to - not only survive - but target optimization, i.e., maximizing the bank's net worth, subject to all the practical constraints encountered by the financial manager and/or portfolio strategist. Given that banks' main costs and earnings are interest paid on short and long-term liabilities and interest earned on short and long-term assets (e.g., loans), AI-focused model making, must be well founded on interest rate variability. That, per se, would necessitate probability related formulation, given the uncertainties inherited in rates expectations.

Hence, our model has been founded on all banking aspects of decision making, such as marketing, PR (as a capital) investment in attracting depositors and investors, and all types of credit seekers. AI department, digital operational department, technology departments, PR strategy department, etc., are the necessities of the most dynamic organizations, and modern baking, where blockchain technology and its crypto currency management would beg for attention and heavy commitment.

This research paper is more heavily weighted on its technicalities and AI modeling than a data-focused empirical study in its nature. We have built a utility function, reflecting banks' customers' consolidated utility or pleasure extracted

from all short-term and long-term loans and other financial instruments provided by banks (and other depository institutions), which would be at the same time banks' investment in short-term and long-term assets (loans, securities, and other credit instruments). The law of diminishing marginal utility justifies the convexity of our indifference curve in selection of various combinations of the two groups of assets, measured in their own market values, say, dollars, which are then appropriately used for both vertical and horizontal axes of our quadrant system.

On the liability side of the equation, all the resources needed to operate a bank would be obtainable through the liability items of the right side of its balance sheet, as well as bank's net worth. Those items include all kinds of short-term and long-term deposits, other various types of -short-term and long–term debt instruments (Repurchase Agreements – or RPs, Bakers Acceptances, borrowed federal fuds, to name a few) and the bank's own equity (net worth). These items are also measured in their own market values, say, dollars, which are then appropriately used for both vertical and horizontal axes of our quadrant system. In this side of the optimization task, we exhibit a concave production possibilities curve, PPC, assuming the appropriately applied law of increasing opportunities cost of every additional unit of each group of the liabilities versus the other group.

The emphatic proposition on the selection of an optimal quantity and quality of public relations capital, PR, as a strategic investment for a sustainable expansion of banks' production possibilities, to be depicted by a right-ward shift in the PPC function, would surely lead to the enhancement of a PR-committed bank's opportunities, conducive to some larger amounts of bank's net worth, the strategic bottom line. Customers would be more prosperous enjoying the supply of various bank loans alongside other banking services. Banking efficiency will transpire into a more prosperous economy.

REFERECES

[1] T. Atashbar, AI and macroeconomic modeling: Deep reinforcement. Washington: International Monetary Fund Publications, February 24, 2023.
[2] F. Castro, J. Gao, and S. Martin, "Does gen AI impose a creativity tax?" MIT Sloan Management Review, Winter 2025.
[3] M. Doumpos, C. Zopounidis, et al., "Operational research and artificial intelligence methods in banking." European Journal of Operational Research, Elsevier Publications, 2023.
[4] T. Gries, W. Naude, Modelling artificial intelligence. Bonn: IZA (Institute of Labor Economics), 2020-2022, retrieved from https://docs.iza.org.
[5] R. Hamzaee, M. Salimi, "An economic approach to - and business application of - artificial intelligence," Management Studies, 2024.
[6] R. Hamzaee, M. Salimi, "Applied artificial intelligence, big data adoption/avoidance in public relations, a proposed applied optimal economic policy model and examination," Archives of Business Research, 11(9), pp. 249-258, doi: 10.14 738/abr.119.15566, 2023.
[7] K. Hosanagar, R. Krishnan, "Who profits the most from generative AI?" MIT Sloan Management Review, *65*(3), 21, Spring 2024.
[8] S. Karim, C. Lee, and H. Weiss, "Improve workflows by managing bottlenecks," MIT Sloan Management Review, Winter 2025.
[9] C. F. Kerry, Report: Protecting Privacy in an AI-driven world, Governance studies, Washington, DC: Brookings Press, February 10, 2020.
[10] T.J. Marion, M. Srour, and F. Piller, "When generative AI meets product development," MIT Sloan Management Review. USA. Fall 2024.
[11] T. Marwala, Economic Modeling Using Artificial Intelligence Methods, New York: Springer, retrieved from https://link. springer.com, 2013.
[12] A. Narang, P. Vashisht, et al., "Artificial intelligence in banking and finance," International Journal of Innovative Research in Computer Science and Technology (IJIRCST), ISSN (Online): 2347-5552, volume 12, issue 2, March 2024.
[13] S. K. Pattanayak, "The impact of artificial intelligence on operational efficiency in banking: A comprehensive analysis of automation and process optimization," International Research Journal of Engineering and Technology (IRJET), volume 08, issue 10, October 2021.