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Synergizing Fuzzy AHP and MAUT for Integrated Evaluation of PSU Stocks and Mutual Fund Schemes

Veerendra Anchan[1], Sahil Shailendra Vaidya[2], Ankita jain[3], Rinkle Chaplot[4]

[1]Assistant Professor, Anil Surendra Modi School of Commerce, NMIMS University, Mumbai

[2,3,4] M.Sc. (Finance) Anil Surendra Modi School of Commerce, NMIMS University, Mumbai

ABSTRACT:

Purpose: The paper deals with the financial performance of public sector firms and mutual fund schemes using fuzzy Analytic Hierarchy Process (AHP) for PSU stocks in the BSE PSU Index and fuzzy Multi-Attribute Utility Theory (MAUT) for PSU mutual fund schemes with Assets under Management (AUM) of 1,000 crores and above.

Methodology: We have used fuzzy AHP to analyze the performance of selected PSU stocks on key performance indicators such as EPS, P/E ratio, and Return on Equity. Fuzzy MAUT is used to evaluate the performance of eligible mutual funds over five years.

Findings: High profitability is evident at BEML Ltd whereas ITI yields negative EPS and ROE. ICICI Prudential exhibits strong performance with positive Sharpe as well as Treynor ratios, whereas the Sharpe ratio of most of the other funds is negative. The PSU stock returns along with their corresponding mutual fund returns highlight the significance of performance measures in investing.

Originality: The paper combines ideas from fuzzy logic with traditional financial analysis to create a more balanced approach to evaluating PSU stocks and mutual fund investments.

KEYWORDS: Public Sector Enterprises, Financial Performance, Fuzzy Logic, Analytic Hierarchy Process, Multi-Attribute Utility Theory, PSU Mutual Funds, BSE PSU Index

1. INTRODUCTION

This paper examines the use of multi-criteria decision-making methods in the selection of PSU equities using Fuzzy AHP and in the valuation of banking and PSU mutual fund schemes using Fuzzy MAUT. PSU equities are of great significance to the economy of India, given that PSU equities indicate the interest of the government and therefore are related to the development of infrastructure. The choice of these equities is significant both to institutional investors and individuals. Since share performance qualitative factors and uncertainties indeed necessitate some kind of assessment strategies, funds that pool resources for professional management will help significantly if focus is on government-owned companies with high returns due to market uncertainty. Existing research uses both quantitative and qualitative techniques for investment decision-making, but a gap remains in systematically applying Fuzzy MCDM methods for PSU stock selection and mutual fund appraisal. Fuzzy AHP effectively addresses qualitative ambiguity through hierarchical comparisons and Fuzzy MAUT enriches mutual fund evaluation through measures of within-quality and inter-quality preference. This research works toward doing better in providing a basis for investment decisions by clearing the financial complexities using strategies that satisfy individual risk tolerance and financial goals toward building knowledge regarding public sector investments and mutual fund strategies.

2. LITERATURE REVIEW

According to Aarushi Singh & Sanjay Kumar Malik (2014) "Due to the complexities of decisionmaking in the real world, sophisticated techniques need to be utilized especially when working with the MCDM model. Some of the primary approaches used that are mentioned here include the WSM, AHP, and TOPSIS. Literature review. These approaches complement each other in making it relatively easier to select the most appropriate alternatives following a critical analysis of the qualitative and quantitative dimensions. For instance, in a case involving the selection of a car, the price, design, mileage, and reliability serve to differentiate the otherwise identical options that originate from the same domain. In order to assist choice-makers in navigating the complexities of choice and arriving at well-informed judgments, the MCDM evaluation process is step-wise against these criteria. The capability of MCDM in solving broad science and narrow science problems is best illustrated through its use in areas that include management, transport, and technology. Future Research Innovation, effectiveness, and adaptability are the key requirements for some future MCDM techniques to be applied to various domains of study. Directions, and more so in the light of breakthroughs in computer science. According toZavadskas & Turskis, (2011) during the last five years, there has been a remarkable rise in research activity in the field of economics. This is with special emphasis on operations research and sustainable development, both of which point towards the growing importance of sound decision-making techniques. The development of Multiple Criteria Decision Making (MCDM) methods, which help in the evaluation and selection of the best options when there is competition in the sense of conflicting preferences between them. At the core of these initiatives are the issues related to the complexities of economic decisions. This literature review focuses on changing the age-old decision-making models to newer models that integrate qualitative criteria with quantitative evaluation. The interplay between individual preferences and the interests of all stakeholders in instituting such structures, the pioneering economists, including Adam Smith and the promises of rational choice theory, emphasize is the concept of constrained rationality, which also helps explain the limits under which humans operate in choice. This indicates that individuals often make choices simple rather than optimal. This can be explained by recent work on stakeholder analysis by von Winterfeldt and Edwards. Then, different considerations may change decisions. The integration therefore underlines the role of MCDM when navigating the complexities of economic decision-making and its ability to create balance among conflicting interests thus well supporting stronger analytical frameworks for further research.

According to *Bonissone et al., (2009)*The three interconnected elements of Multi Criteria Decision Making (MCDM)—solution search, preference trade-offs, and interactive visualization—are positioned in this research as an integrative framework. In order to find nondominated solutions within the Pareto set—a process made more difficult by non-convexity and nonlinear evaluations—effective search algorithms are essential for navigating complex, high-dimensional solution spaces. The authors discuss the crucial process of preference aggregation at the same time, in which decision-makers express and hone their preferences— which are frequently ill-defined and dynamic—in order to choose the best options. Improvements in Bayesian and fuzzy decision-making techniques have enhanced this element. It is stressed that the interactive visualization process is essential for integrating decisionmakers into the iterative selection and refinement process, enabling them to successfully comprehend and manage trade-offs. The difficulties presented by ambiguity in input data, decision-makers cognitive limits, and the requirement for decision-chain transparency are all highlighted in the study. The authors clarify the usefulness of MCDM approaches and promote further study to increase their applicability to intricate real-world situations by providing a requirement framework and case studies in electric power management, financial portfolio optimization, and air traffic planning. This combination of search, preference, and visualization highlights how MCDM may offer strong answers to complex decision-making problems across a range of fields.

According to *Asadabadi et al., (2019)* Many firms still prefer intuitive decision-making techniques, though they are given the theoretical benefits of Multi Criteria Decision Making techniques, especially the Analytic Hierarchy Process (AHP) and the Analytic Network Process (ANP). This study reveals a significant discrepancy between the suggested effectiveness of MCDM techniques and their actual use, especially with respect to AHP's intrinsic weaknesses, which include problems with pairwise comparisons and Saaty's constraints. A related study states that decision-makers are more likely to have a hard time forming consistent decisions if there are more criteria; thus, inflated Consistency Ratios and subsequent debates in the accuracy of rankings produced by AHP arise. As a result of the disagreement, decision-makers often change their ratings to achieve artificial cutoff points, which vitiates the authenticity of their selections and nullifies the outcomes. It has also negated empirical research that ensured that the ranking from MCDM is superior to intuitive methods. For example, the researches by Ishizaka and Siraj are negated because the relatively straightforward MCDM can attain rational rankings more than AHP. The results present an urgent necessity for designing more reliable and user-friendly MCDM techniques that are able to circumvent the limitations of traditional methods and thus enhance adoption and confidence among practitioners

According to *Bhole, (2018)* Multi Criteria Decision Making MCDM: is an important framework to analyse and make decision about choosing the best solutions in varied domains. It applies various techniques such as the Analytic Hierarchy Process AHP and Technique for Order of Preference by Similarity to Ideal Solution are increasingly being applied in real world scenarios, MCDM, with earlier historical roots to utility theory as presented by Von Neumann and Morgenstern in the 1940s. A very rich literature accounts for the usefulness of the MCDM techniques applied in handling complicated decision-making scenarios in all forms, from waste management and financial analysis to infrastructure development and healthcare. Applications in project for example, selection and urban sustainability, have shown that the hybrid methods of which many MCDM methods are hybrids do better in optimizing a solution in addition, the current literature shows that the integrated methods tend to outperform single methodology approaches when there is rivalry among criteria to be appropriately solved, resulting in strengthening the decision-making legitimacy. According to *Moradpour (2021)*multi-criteria decision making (MCDM) models should be used in a complex process of mutual fund performance appraisal to rank funds for evaluation against a number of performance measures. It suggests that an upside potential along with a downside covariance should not be ignored in the performance appraisal. Potential as well as downside risk in performance evaluations by applying the post-modern portfolio theory to set critical performance criteria validated by industry experts. Mutual funds have increased drastically globally, according to the historical trends, and their adoption indicates a shift towards sophisticated investment vehicles in marketplaces characterised by high competition. More recent performance measures like the Sortino ratio have replaced classic benchmarks like the Sharpe ratio, in which risk-adjusted returns is the first priority for comprehensive evaluations. Recent advancements of contemporary models, as Support Vector Machines (SVM) and the PROMETHEE method show just how well these models can rank reliably within Iran's capital market, where traditional methods have become in disrepute due to poor performance. This group of This approach stressed the need for proper adaptation of this holistic approach by the fund managers to cover a wide range of performance measures that would make the investors more transparent and well-informed about their investment decisions. The results would further feed in to augment a comprehensive understanding of mutual fund efficiency through performance appraisal, which eventually leads to the boosting of investor confidence and market competitiveness. To examine criteria and their dependency, Fazli & Jafari (2012) proposed a hybrid multiple criteria decision-making (MCDM) model for stock market investments that adopts VIKOR method integrated with the Analytical Network Process (ANP) and DEMATEL. The outcomes identify two champion players and reveal that profitability ratios are of vital importance for investment decisions in the Iranian stock market. Akbaş & Erbay Dalkiliç, (2021), on the other hand, provides a two-stage hybrid approach for portfolio selection that includes fuzzy linear programming and applies the Constrained Fuzzy Analytic Hierarchy Process (Fuzzy AHP) in order to incorporate both quantitative information as well as expert qualitative assessments. Their empirical study of Dow Jones stocks between 2018 and 2020 was characterized to have preferable investing results compared to traditional models addressing investor preferences amid uncertainty. They achieve this using trapezoidal fuzzy numbers, which provide more precision

Varmazyar et al., (2016) argue that for a more apt diagnosis of organizational performance in RTOs, the BSC is increasingly being integrated with MCDM methodologies. This, through techniques such as ANP, DEMATEL, and TOPSIS, for instance, Hybrid approach can improve performance evaluations to incorporate non-financial and financial metrics. Using the intuitionistic fuzzy analytic hierarchy process (IFAHP) of portfolio selection integrating qualitative and quantitative criteria,. *Senfi et al., (2024)* illustrate its effectiveness on the Tehran Stock Exchange. When making investing decisions, *Jana et al., (2024)* require financial indices incorporating the Price PEG ratio. Finally, Alg & Biswas, (2024) employ fuzzy MCDM frameworks to study stock market responses during the COVID-19 pandemic and observe some resilience in certain global indices. *Elmas et al., (2024)* examined biases among individual investors in Borsa Istanbul and found that regret aversion and overconfidence have a huge impact on investment behavior, with regret aversion most impactful. Investors and overseers may gain from the study through applying the Analytical Hierarchy Process AHP.

Işık et al., (2024) evaluate non-life insurance companies in Turkey by a hybrid model through MAIRCA and Pythagorean Fuzzy AHP. The approach focuses on stock performance and service network, and it, therefore, determined that Halk Sigorta is the most consistent leader. *Alfiana et al., (2024)* concluded that inflation has a negative effect and that the there positive correlations with the Jakarta Composite Index. For better investment techniques in the fields of sustainability and risk management *Garcia-Bernabeu et al., (2024)* suggest the use of a multi-objective genetic algorithm which takes into account ESG factors in portfolio optimization.

According to *Vuković et al., (2020)* the comparative study between hybrid multi-criteria decision-making MCDM models and classic Modern Portfolio Theory MPT models of stock selection and portfolio optimization. The aim is to observe how such models, incorporating a much larger set of financial variables, operate in different market conditions and the effects thereof on investment decisions. There also appears to be some weakness in the capability to include aspects of behavior as well as industry-specific information in those models. Future areas for research would be in exploring how insights of behavioural finance can be used better to: The research areas include the psychological influences on investment decisions and the impact of industry-specific characteristics on stock rankings and portfolio performance. For this study, the techniques selected are Analytic Hierarchy Process (AHP) and Simple Additive Weighting (SAW). (Chen and Ren, 2022) examine if funds driven by Artificial Intelligence outperform human-managed funds. It finds that the funds powered by AI outperform in stockpicking efficiency and reducing transaction costs significantly due to their superior data analytics capabilities and Reduced behavioural biases. The study indicates that AI funds will perform better than human-managed funds in general but the benefit is not uniform. More comparative research needs to be done on different kinds of market conditions, different types of funds and strategies to fully understand the benefit and limitations of AI. This study made use of the sources from CRSP and COMPUSTAT. Poklepović & Babić, (2014) proposed and experimented upon a hybrid multiple criteria A stock selection MCDM approach. To produce one rank of stocks, the approach averages rankings from these distinct MCDM methods— COPRAS, linear assignment, PROMETHEE, SAW, and TOPSIS—using Spearman's rank correlation coefficient. This research aims to reduce a disparity between these methods and the improvement of stock rating accuracy by taking into account, generally those of a financial type and specific factors of an industrial nature. The authors would also like to contribute to the deeper theoretical and empirical knowledge of hybrid MCDM methods and to suggest future developments in integrated methodology.

Atta Mills et al., (2020) presents in this paper a hybrid grey MCDM strategy that combines Analytical Network Process (ANP) and the Decision-Making Trial and Evaluation Laboratory Improvement in the portfolio selection process using the DEMATEL methods Reduce uncertainty and interdependency among criteria for decision-making by facilitating weight and ranking in the grey environment. It discusses and analyses the effectiveness of this hybrid strategy on the Shanghai Stock Exchange, and examines effectiveness and accuracy comparatively against conventional techniques. Instead, it pays specific attention to the necessity for further extension of this approach to other financial markets and asset kinds to ensure its broad application and generalizability.

According to Bimonthly *(2019) study by Swati Kumari.* analyses the financial as well as operational performance of Central Public Sector Enterprises (CPSEs) and its subsidiaries of the period 2013 to 2018. The study provides a thorough evaluation of each and every performance-related component of CPSEs for determining the overall impact and effectiveness.

*Alptekin's (2009)*study assesses the performance of Turkish pension and Type A equity mutual funds from January 2007 to December 2008. The research evaluates the funds using TOPSIS after using performance measuring tools such as Sharpe ratio, Sortino ratio, Treynor index, and Jensen's alpha. Here, it determines which funds are closer to the ideal performance measurements and which are farthest from the negative ideal. This study focuses on the Turkish market but shows that future research might extend to Indian markets, by using several MCDM and MADM methods and also by integrating sector-specific stock selection analysis.

Kanwar and Ghosh's (2023) study analyses the application of Multi-Criteria Decision-Making (MCDM) approaches for ranking sectoral indices at National Stock Exchange (NSE). It analyses the sensitivity of different MCDM approaches, namely CRITIC, SAW, TOPSIS, ARAS, COPRAS, and EDAS, while analysing these indicators. Paper also analyses the impact of "feature weighting" on the performance of the various approaches-precision, scalability, and dependability. It fills this gap by suggesting feature weighting to enhance MCDM approaches and the following studies must be taken into consideration: using higher size datasets, a wider range of indices, and incorporation of machine learning in order to increase their powers of prediction. in economic decision-making. Cui & Cheng's (2022) study investigates the use of

Modern Portfolio Theory (MPT) to build trading portfolios in Australia. The project is targeted at constructing an MPT-based trading algorithm that would be useful for acquiring profitable and reliable returns. Major elements influencing the algorithm performance and ways of improving it by overcoming constraints such as limited data and Calculation distortion. Improvement suggestions include using robust methods for the management of missing values, inclusion of explicit data and time varying risk-free rates, user personalization, and study of alternative techniques for portfolio optimization.

According to Senthilkumar et al., (2022) the performance of sector-specific scrips to broadmarket indices in the Indian stock market. It evaluates the portfolios based on sector-specific investment strategies and those that perform better based on broad market indices. Furthermore, the study evaluates the Sharpe Single Index (SIM) model as an alternative to the Modern Portfolio Theory (MPT) model for portfolio optimization. The study identifies a vacuum in existing research, which frequently focuses primarily on MPT while ignoring the potential benefits of sector-specific investments and the SIM model. Future study could look into dynamic weighting, multi-asset class portfolios, causal factors, machine learning integration, and a global viewpoint. *Gupta et al., (2023)*offer a hybrid framework for stock selection in the Indian stock market that combines Bayesian classification, TOPSIS, and Entropy techniques. This framework handles issues such as risk-adjusted ratios and non-normal return distributions. Its goal is to uncover critical elements impacting stock performance and selection while comparing its efficacy to standard portfolio construction techniques. The paper identifies a gap in past research, which frequently ignores the influence of non-normal returns and does not use Bayesian categorization. Future study could expand by incorporating more risk-adjusted ratios, investigating alternative hybrid MCDM methods, and addressing TOPSIS method constraints.

*According to Kou et al., (2021)*Fintech investments in European banks using a hybrid multidimensional decision-making model. The model combines IT2 fuzzy DEMATEL and IT2 fuzzy TOPSIS to evaluate and rank investment options using financial and non-financial variables. Payment systems and money transfer technologies are among the key investment sectors mentioned, as they improve customer happiness, operational efficiency, and cost reduction. The study emphasizes the necessity for comparative studies across areas, as Fintech practices may differ globally. Future study should broaden the evaluation criteria to include elements such as customer experience, regulatory compliance, and future technology to provide a more complete assessment. The study makes decisions using TOPSIS and sensitivity analysis. Kiriş & Ustun's (2012) The research aims to determine the best portfolio composition based on an analysis of stocks from the ISE30 index. However, as this study relies on a single measure, its generalizability might be restricted by the approach. Future study could expand the applicability of the model by including other indexes or market segments around the globe. In addition, the development of clear guidelines on how to apply fuzzy MCDM, like procedures in setting and changing fuzzy parameters, could add more accuracy and interpretability of the stock assessments. The paper focuses on the multi-objective portfolio optimization strategy *According to Bakry et al., (2021)* emphasized the role of Bitcoin in the aspect of portfolio diversification based on traditional optimization techniques, which include equal-weighted and risk-parity techniques. It checks whether Bitcoin is the leading asset in the diversification context compared to the other digital currencies. As per the It might provide deeper information on a more complex or hybrid optimization framework for further study. It also suggests knowledge gaps in the behavior of Bitcoin under extreme market conditions or longer bear markets prevailing. Future studies may be even more complex and use methodologies such as the Black-Litterman model, Conditional Value-at-Risk (CVaR), or multi-objective optimization to better understand Bitcoin's role in portfolio diversification. The study adopted MCDM and CVaR to optimize the portfolio.

3. RESEARCH METHODOLOGY

3.1 Fuzzy AHP:

In today's financial markets, seeking stocks based on strong research can be very much extremely important for Minimizing risk and maximizing rewards: Multi-Criteria DecisionMaking (MCDM) Techniques are helpful in providing insight into the selection of the best stocks to invest in portfolios, with an increasingly long list of stock appraisal measures. Among these, the Fuzzy Analytical Hierarchy Process (Fuzzy AHP), which deals with subjectivity and ambiguity in the decision-making while studying many quantitative factors for choosing an appropriate stock.

3.1.1: Data Collection:

To provide an analytical review of the risk and financial performance of Public Sector Undertakings (PSUs) in India, data on 59 PSU stocks over several financial parameters are collected. The relevance of these criteria in assessing the performance of stocks and their financial health would lead to their careful selection. An exhaustive dataset containing multiple important Several financial variables have been developed in order to evaluate the financial health and the performance of both the stocks and mutual funds. Such variables are Earnings Per Share (EPS), Price to Earnings Ratio (P/E), Price to Book Ratio (P/B), Price to Sales Ratio (P/S), and Return on Equity (ROE). There are also Standard Deviation, Variance, 5-Year Daily Average Return, and Return on Assets. (ROA) are presented. These have been chosen because of the presence of an already developed relevance for use in financial performance evaluation and company's stock performance. Profitability measures include the use of a firm's EPS (earnings per share) while value ratios encompass the P/E and P/B as measures that assess the valuation of the firm with respect to its book value and earnings, respectively. The P/S ratio is used to analyse the degree of efficiency of revenues. This last set of data adds creation, as well as ROE and ROA, as measures of the company's ability to generate returns on equity and assets, respectively. To add an extra layer of long-term performance risk, Standard Deviation, Variance, and the 5-Year Daily Average Return are included. The data set used is so inclusive; it can form a very good basis for further study and gives insight into the company's financial features of the PSU stocks that are being investigated. This study attempts to gain some valuable insights into the risk characteristics, investment potential, and financial performance of PSU stocks and mutual funds existing in Indian stock exchanges so as to make better selection.

3.1.2 Transposing Data

The raw financial data for all PSU stocks and funds is standardized with much care to Thus, FAHP will definitely be implemented in an effective manner. All the financial ratios and returns would be squared out to balance the calculations ahead. This would entail achieving uniform formatting of the data. Moreover, the FAHP algorithm would process and This would do data with presenting more reliable and accurate analysis by harmonic data structure. It was established following the communality among the stocks, which were developed by this Standardization process makes it possible to compare and assess them meaningfully.
Accordingly, based on their risk and financial performance.

3.1.3 Fuzzy AHP Matrix Construction

By the consideration of the respective weights of the chosen financial factors, a fuzzy pairwise the evaluation matrix is constructed. To convey the inherent vagueness and uncertainty in human Triangular fuzzy numbers were used in the comparative process for judgment. Fuzzy AHP. For each criterion pair-wise comparison matrices are built by both direct Numerical analysis and sound professional judgment to build a better structure for the relevance ranking of the considered financial elements. The matrices are therefore to fuzzify, TFNs are passed through the comparisons. Fuzzy aggregation Then, there are methods, like the geometric mean method used to aggregate the fuzzy pairwise Combine the comparison matrices into one matrix for each stock. After combining, the centre Then, fuzzy values are defuzzified into crisp values using the ranking method by using an approach. The 59 PSU stocks are graded and ranked according to those very same numbers, which Indicate the relative weights of each financial component. The following is an exhaustive list ranked: It is thus obtained by simply adding the weighted scores assigned to every stock. This gives much-needed Some data on the relative investment attractiveness of stocks, taking into account both the risk It provides an overall profile and their financial performance. More notable and enlightened than more Unlike conventional quantitative approaches, this approach is based on the Fuzzy Analytical End Hierarchy Process (FAHP)—allows decision-makers to make highly informed economic Decisions

Formula for Pairwise Comparison Matrix (A):

$$A = \left(\frac{a_{ij}}{a_{ji}}\right) \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots (1)$$

Where a_{ij} is the value from criterion *i* compared to criterion *j* and vice versa.

The pairwise comparison values in fuzzy AHP are typically represented by triangle fuzzy numbers (TFNs), denoted as

$$\tilde{a}_{ij} = (l_{ij}, m_{ij}, u_{ij})$$

lij : Lower bound (minimum possible value).

m_{ij}: Most likely value;

u_{ij} : Upper bound (maximum possible value).

Formula for Fuzzification of the Pairwise Matrix:

$$\tilde{A} = [\tilde{a}_{ij}] = (l_{ij}, m_{ij}, u_{ij}) \dots \dots \dots \dots \dots \dots \dots (2)$$

Aggregation Formula (for Geometric Mean):

$$\tilde{a}_i = \prod_{j=1}^{n} \tilde{a}_{ij} \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots (3)$$

where $\tilde{a}_i$ is the fuzzy number for each stock, and n is the number of criteria.

Formula for Defuzzification of the Fuzzy Matrix

$$A^* = \frac{l_{ij} + m_{ij} + u_{ij}}{3} \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots (4)$$

Formula for Normalization of Crisp Weights:

$$W_i = \frac{A_i^*}{\sum_{j=1}^{n} A_j^*} \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots (5)$$

3.2 Fuzzy Multi-Attribute Utility Theory (MAUT):

Fuzzy Multi-Attribute Utility Theory MAUT by utilizing the Multi-Criteria Decision-Making MCDM framework for analysing and ranking the Banking and Public Sector Undertaking. PSU Debt Mutual Funds. Applying fuzzy logic, the proposition is to consider the intrinsic

Subjectivity and vagueness permeate financial appraisals and allow for much more refined assessments of Investment opportunities. The structured approach proposed involves a fuzzy decision matrix, Normalizing Performance Indicator, Computation of Criterion Weights, and Calculation of Aggregate Ranking scores. This approach attempts to offer the investor a comprehensive It links quantitative and qualitative assessment, enhancing more complex decision making in this fast-changing investment world.

3.2.1 Information Collection:

Information garnered for this study was obtained from top financial websites that host Money Control, aside from the specific websites of individual mutual funds. The emphasis has been Only in Banking and PSU Debt Fund schemes, truly forming the bedrock of risk return profiles in the emerging market landscape. Beginning with, based on there were 21 schemes identified. On their market presence, the choice has come down to 15 schemes which meet the on an absolutely basis of a threshold of ₹ 1000 crores AUM. This cut-off had that were established to ensure that only sufficiently large and stable funds were analysed, thereby Enhance Relevance and Validity of the Outcomes of All Performance Measures Identified for the study is, therefore scrutinized to authenticate its significance in the making of decisions. It is for processes so they can appropriately capture the financial health and risk profile of every fund.

3.2.2 Fuzzy matrix construction:

These are then included in a fuzzy decision matrix for the next step in the analysis. the desired performance measures. The following matrix attempts a very rough outline of Every mutual fund scheme's performance compared against the given criteria. The decision matrix A fuzzy deal with innate uncertainties and variabilities presents in financial data. framework. It is important because in practice all financial measures are always approximated and Subjective, therefore, it requires a flexible decision-making paradigm that indeed reflects the intricacies of mutual fund reviews.

3.2.3 Normalization of the Fuzzy Matrix:

The fuzzy matrix is such that for equitable comparison across different performance indicators. normalized values acquired using min-max scaling method. The process transfers every to a common scale, which makes the comparison of data much easier. The normalized It also finds the score value for each criterion based on the minimum of scores. and extrema for that objective function. The normalization procedure is important, because it providing a solid platform for analysis, hence enabling subsequent decision-making procedures.

Formula for Normalization of the Fuzzy Matrix:

To obtain the normalized score (N) for each performance metric (j) and scheme (i), follow these steps:

$$Nij = \frac{(Xj) - min(Xj)}{Max(Xij) - min(Xj)} \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots (6)$$

Where;

Xij is the original score of schemes i for metric j

Min (Xj) is the minimum score for metric j across all schemes.

Max (Xin) is the maximum score for metric j across all schemes.

3.2.4 Weight Calculation:

All performance parameters assigned a respective weight that results from the value viewed in terms of mutual fund performance review. The weights are derived using the N-Rank formula, which is a combination of the total number of criteria and the rank assigned to each individual criterion. This ranking incorporates quantitative measures along with qualitative information; it thus forms a hierarchy of performance metrics: Sharpe Ratio, Jensen's Alpha, Treynor Ratio, Average 10-Year Return, Beta, Standard Deviation, Assets Under Management (AUM), and Expense Ratio. This hierarchical rating thus conveys each metric's relative importance for the overall performance and suitability of mutual fund schemes and its alignment with investor objectives and risk tolerance.

Formula for Weight Calculation

The N-Rank formula is used to calculate the weight (W) for each performance metric (j). Each criterion is assigned a rank (R j) and the total number of criteria (n). Weight is calculated as:

$$\mathrm{Wj}= \frac{\mathrm{n{-}Rj{+}1}}{\sum_{k=1}^{n} n - \mathrm{Rk}+1} \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots (7)$$

Where:

- n is the total number of performance metrics.
- Rj is the rank assigned to metric j

3.2.5 Aggregate Score Calculation and Ranking:

Aggregation of scores for every scheme of mutual funds through multiplication of normalized values by respective weights marks the final step in the calculation process. This computation method evaluates the overall performance of each fund by summing the strengths of that fund across all chosen performance criteria into a single quantitative score. Using aggregate scores, the mutual fund schemes are rated so that the potential investor could make judgments that are well-informed and based on a holistic understanding of mutual fund performance dynamics. This provides an organized process that not only improves the reliability of the performance assessment but also helps in reducing the ambiguity sometimes connected with financial evaluations.

The aggregate score Si for each scheme "I" is computed as follows:

$$\mathrm{Si}=\sum_{j=1}^{m} N\mathrm{ij}\cdot\mathrm{Wj}\ldots\ \ldots\ \ldots\ \ldots\ \ldots\ \ldots\ \ldots\ \ldots\ \ldots\ (8)$$

Where; Nij is the normalized score for scheme iii for metric j Wj is the weight assigned to performance metric j m is the total number of performance metrics.

4. RESULTS AND INTERPRETATION:

4.1 PSU Stocks:

The dataset gives the insight into several financial parameters about several organizations, and some reveals a considerable variation in the key performance indicators such as EPS, P/E ratio, P/B ratio, and ROE. For instance, BEML Ltd shows a very high EPS of 67.96 and a ROE of 11%, which means strong profitability and effective usage of equity. On the contrary, ITI's -5.8 EPS and -27.80% ROE are warning signs of critical operational inefficiencies and pending financial troubles. The P/E ratios vary in a very wide range-from a rather too high 922 from Bharat Heavy Electricals to a minimum of 6.05 at Canara Bank-which points towards market values and differing perceptions that investors have regarding future growth prospects.

Table I: Calculation of Fuzzy TFN Matrix (Source: Author Generated)

	EPS	P/E	P/B	P/S	ROE	ROA	DAILY AVERAGE RETURN	S.D	VARIANCE	L	M	U
EPS	(1,1,1)	(3,4,5)	(2,3,4)	(2,3,4)	(4,5,6)	(3,4,5)	(3,4,5)	(2,3,4)	(2,3,4)	2.289428	3.093171	3.863968
P/E	(1/5,1/4,1/3)	(1,1,1)	(1,2,3)	(1,2,3)	(3,4,5)	(2,3,4)	(2,3,4)	(1,2,3)	(1,2,3)	1.102163	1.737073	2.346901
P/B	(1/4,1/3,1/2)	(1/3,1/2,1)	(1,1,1)	(1,2,3)	(2,3,4)	(1,2,3)	(1,2,3)	(1,2,3)	(1,2,3)	0.819481	1.36079	1.988452
P/S	(1/4,1/3,1/2)	(1/3,1/2,1)	(1/3,1/2,1)	(1,1,1)	(2,3,4)	(1,2,3)	(1,2,3)	(1,2,3)	(1,2,3)	0.006173	0.444444	1.759955
ROE	(1/6,1/5,1/4)	(1/5,1/4,1/3)	(1/4,1/3,1/2)	(1/4,1/3,1/2)	(1,1,1)	(2,3,4)	(1,2,3)	(1,2,3)	(1,2,3)	0.543916	0.799413	1.276518
ROA	(1/5,1/4,1/3)	(1/4,1/3,1/2)	(1/3,1/2,1)	(1/3,1/2,1)	(1/4,1/3,1/2)	(1,1,1)	(1,2,3)	(1,2,3)	(1,2,3)	0.481414	0.725313	1.094287
DAILY AVERAGE RETURN	(1/5,1/4,1/3)	(1/4,1/3,1/2)	(1/3,1/2,1)	(1/3,1/2,1)	(1/4,1/3,1/2)	(1/4,1/3,1/2)	(1,1,1)	(1,2,3)	(1,2,3)	0.412689	0.59438	0.896747
S.D	(1/4,1/3,1/2)	(1/3,1/2,1)	(1/3,1/2,1)	(1/3,1/2,1)	(1/4,1/3,1/2)	(1/4,1/3,1/2)	(1/3,1/2,1)	(1,1,1)	(1,1,1)	0.386598	0.487083	0.793701
VARIANCE	(1/4,1/3,1/2)	(1/3,1/2,1)	(1/3,1/2,1)	(1/3,1/2,1)	(1/4,1/3,1/2)	(1/4,1/3,1/2)	(1/3,1/2,1)	(1,1,1)	(1,1,1)	0.386598	0.487083	0.793701

This data table provides an overall comparison of several financial metrics using paired comparison methods to derive relative importance weights across key performance indicators like Earnings Per Share (EPS), Price-to-Earning (P/E) ratio, Price-to-Book (P/B) ratio, Priceto-Sales (P/S) ratio, Return on Equity (ROE), Return on Assets (ROA), daily average return, standard deviation (S.D.), and variance. Each of the measures is assessed using a set of comparative pairs that result in a hierarchical framework highlighting the interdependence and relative weight of each financial measure. Those weights actually illustrate a well-defined hierarchy, and EPS, P/E, and ROE therefore constitute three performance indicators that are important for companies, while P/B and P/S ratios together with variance and standard deviation as a means of measurement of risk can be read in a meaningful way, setting the context for volatility and the valuation of firms at the market. This multi-factor approach not only facilitates more nuanced interpretation of the results but also provides strategic insight into where one should and should not invest because it explains the underlying financial health and future growth possibilities of the companies comprising this study.

Table II: Calculation of Crisp Weights of PSU Stocks (Source: Author Generated)

Sr. no	**Fuzzy geometric mean**	**Fuzzy Weights**	**Fuzzy Weight addition**	**Weights**	**Normalisesd weights (Crisp Values)**
1	[2.289, 3.093, 3.863]	[0.355,0.318,0.261]	0.935668	0.311	0.31
2	[1.102, 1.737, 2.346]	[0.171,0.178,0.158]	0.507221	0.169	0.17
3	[0.819, 1.360, 1.988]	[0.127,0.139,0.134]	0.401642	0.133	0.13
4	[0.006, 0.444, 1.759]	[0.0009,0.045,0.118]	0.165266	0.055	0.06
5	[0.543, 0.799, 1.276]	[0.084,0.082,0.086]	0.253105	0.084	0.08
6	[0.481, 0.725, 1.094]	[0.074,0.074,0.073]	0.223057	0.074	0.07
7	[0.412, 0.594, 0.896]	[0.064,0.061158,0.060]	0.185685	0.061	0.06
8	[0.386, 0.487, 0.793]	[0.060,0.050,0.053]	0.163658	0.054	0.05
9	[0.386, 0.487, 0.793]	[0.060,0.050,0.053]	0.163658	0.054	0.05
				0.999	1.00
Geometric mean Summation	Geometric mean Reciprocal				
6.428	0.155				
9.728	0.102				
14.814	0.067				
	[0.155, 0.1027, 0.0675]				

The relative weights of several financial criteria in rating corporate performance are illustrated through the analysis of crisp weights generated from fuzzy geometric means. Fuzzy geometric means represent the condensed expert evaluation for each statistic from EPS to Variance, while fuzzy weights derived from these means denote the relative priorities assigned by experts. In this manner, a hierarchy is uncovered in their contribution towards the general rating of performance.

Normalized crisp weights, the ratios of each metric's fuzzy weight divided by total fuzzy weight, are easily read and applied. There is, for example, the highest normalized weight assigned to EPS in the investment decision-making process, which shows that its importance is most critical, while measures such as S.D. and Variance have relatively smaller weight values, meaning they have a smaller impact in the setting. It prioritizes metrics in a way that stakeholders focus on the most important financial indicators. Results show not only the systematic rigor of applying fuzzy logic to financial analysis but also its use in turning hard judgments into actionable insights, hence improving strategic investment decisions and risk management techniques.

The investment stocks were chosen from the overall cumulative scores that reflected a comprehensive analysis of key financial performance parameters. The top companies within the list highlighted BEML Ltd, Bharat Heavy Electricals Limited, Cochin Shipyard, Gujarat Gas, Hindustan Aeronautics, Indian Bank, LIC of India, Mazagaon Dock Shipbuilders, Power Finance Corporation, and State Bank of India. With aggregate scores so high, these companies have sound fundamentals in metrics such as Earnings Per Share (EPS), Price-to-Earnings (P/E) ratio, and Return on Equity (ROE). One should keep in mind that the approach of such analysis focuses on the fact that they happen to be quite potential appealing investment possibilities for those 'smart' investors searching for an improved portfolio performance.

4.2 Banking & PSU Mutual Fund Schemes:

Major banking and PSU debt funds are reviewed based on the risk-adjusted returns as well as overall investment acceptability. Important financial criteria include standard deviation, beta, Sharpe ratio, Jenson's alpha, Treynor's ratio, expense ratio, assets under management, and average 10-year returns.

This analysis of banking and PSU debt funds shows huge variation in performance parameters that signifies an environment of risk, return, and efficiency with differing degrees. The standard deviations express different volatility, HSBC is the highest danger, whereas beta values signify more market vulnerability. Negative Sharpe ratio prevalence threatens risk-adjusted returns, however, but ICICI Prudential presents at positive Sharpe and Treynor ratio which seems to reflect good management of the market risks.

If we are to make some judgement on Jenson's alpha, we can say that HSBC is able to offer more returns. However, expense ratios range from 0.41% to 0.81%, thus suggesting that cost management should be one critical factor in determining which fund to choose. Of course, investors must consider their risk appetite and their specific investment goals as they navigate this rather complex world; in any case, ICICI Prudential looks like a pretty compelling offer at a time when conditions are generally difficult.

Table III: Fuzzy Matrix of Banking & PSU Mutual Fund Schemes Having AUM More than 1000 Crores (Source: Author Generated)

Scheme Name	Standard Deviation (l, m, u)	Beta (l, m, u)	Sharpe Ratio (l, m, u)	Jensen's Alpha (l, m, u)	Treynor's Ratio (l, m, u)	Expense Ratio (l, m, u)	AUM (l, m, u)
Aditya Birla Sun Life Banking & PSU Debt Fund	(0.0, 0.27, 0.44)	(0.0, 0.18, 0.27)	(0.0, 0.22, 0.75)	(0.0, 0.24, 1.0)	(0.0, 0.62, 1.0)	(0.0, 0.29, 0.65)	(0.0, 0.15, 1.0)
Axis Banking & PSU Debt Fund	(0.0, 0.18, 0.27)	(0.0, 0.06, 0.09)	(0.0, 0.10, 0.75)	(0.0, 0.16, 0.57)	(0.0, 0.57, 0.78)	(0.0, 0.29, 0.65)	(0.0, 0.15, 1.0)
Bandhan Banking & PSU Debt Fund	(0.0, 0.27, 0.36)	(0.0, 0.18, 0.21)	(0.0, 0.10, 0.75)	(0.0, 0.24, 0.43)	(0.0, 0.57, 0.78)	(0.0, 0.29, 0.65)	(0.0, 0.15, 1.0)
DSP Banking & PSU Debt Fund	(0.25, 0.36, 0.44)	(0.0, 0.12, 0.16)	(0.0, 0.22, 0.75)	(0.0, 0.40, 0.43)	(0.0, 0.78, 1.0)	(0.0, 0.20, 0.50)	(0.0, 0.15, 1.0)
HDFC Banking & PSU Debt Fund	(0.0, 0.09, 0.18)	(0.0, 0.18, 0.21)	(0.0, 0.12, 0.75)	(0.0, 0.20, 0.43)	(0.0, 0.78, 1.0)	(0.0, 0.35, 0.78)	(0.0, 0.15, 1.0)
HSBC Banking and PSU Debt Fund	(0.5, 0.64, 0.72)	(0.9, 1.0, 1.0)	(0.0, 0.0, 0.75)	(1.0, 1.0, 1.0)	(0.0, 0.0, 0.5)	(0.0, 0.35, 0.78)	(0.0, 0.15, 1.0)
ICICI Prudential Banking & PSU Debt	(0.0, 0.27, 0.36)	(0.0, 0.0, 0.18)	(0.0, 0.44, 0.75)	(0.0, 0.16, 0.43)	(0.0, 0.0, 0.5)	(0.0, 0.29, 0.65)	(0.0, 0.15, 1.0)

Fund							
Kotak Banking and PSU Debt Fund	(0.0, 0.18, 0.27)	(0.0, 0.0, 0.0)	(0.0, 0.0, 0.75)	(0.0, 0.16, 0.43)	(0.0, 0.0, 0.5)	(0.0, 0.29, 0.65)	(0.0, 0.15, 1.0)
LIC MF Banking & PSU Fund	(0.0, 0.18, 0.27)	(0.0, 0.12, 0.12)	(0.0, 0.10, 0.75)	(0.0, 0.16, 0.43)	(0.0, 0.0, 0.5)	(0.0, 0.29, 0.65)	(0.0, 0.15, 1.0)
Nippon India Banking & PSU Debt Fund	(0.0, 0.18, 0.27)	(0.0, 0.0, 0.12)	(0.0, 0.0, 0.75)	(0.0, 0.16, 0.43)	(0.0, 0.0, 0.5)	(0.0, 0.29, 0.65)	(0.0, 0.15, 1.0)
SBI Banking and PSU Fund	(0.0, 0.27, 0.36)	(0.0, 0.12, 0.15)	(0.0, 0.0, 0.75)	(0.0, 0.24, 0.43)	(0.0, 0.0, 0.5)	(0.0, 0.0, 0.5)	(0.0, 0.15, 1.0)
Sundaram Banking & PSU Fund	(0.0, 0.36, 0.45)	(0.0, 0.12, 0.15)	(0.0, 0.0, 0.75)	(0.0, 0.24, 0.43)	(0.0, 0.0, 0.5)	(0.0, 0.0, 0.5)	(0.0, 0.15, 1.0)

This kind of fuzzy matrix analysis of Banking and PSU loan funds reveals that there is an inherent variability and uncertainty in such important performance criteria that are represented as triangle fuzzy numbers (l, m, u). The standard deviations revealing large changes in returns range from (0.90, 1.00, 1.30) to (1.50, 1.70, 1.80). The same funds-creating a fuzziness-and higher the-beta values-HSBC also has the highest beta values-reveal increased exposure to systematic risk-which are exposed mostly to volatile returns. Notably, the prevalence of negative Sharpe ratios among numerous funds highlights insufficient risk-adjusted returns, with ICICI Prudential emerging as a possible anomaly. Jensen's alpha variability demonstrates varying capacities for generating excess returns, which are exacerbated by mostly negative Treynor ratios, indicating issues in systematic risk management. While expense ratios remain reasonably stable (0.30% to 0.90%), demonstrating the need of cost efficiency, consistent AUM statistics indicate strong investor confidence, albeit moderated by liquidity concerns. Overall, this fuzzy matrix methodology provides a sophisticated lens through which investors can negotiate the complexity of risk and return in the Banking and PSU debt fund sector.

Table IV: Normalized Matrix of Banking & PSU Mutual Fund Schemes Having AUM More Than 1000 Crores (Source: Author Generated)

Scheme Name	Standard Deviation (l, m, u)	Beta (l, m, u)	Sharpe Ratio (l, m, u)	Jensen's Alpha (l, m, u)	Treynor's Ratio (l, m, u)	Expense Ratio (l, m, u)	AUM (l, m, u)
Aditya Birla Sun Life Banking & PSU Debt Fund	(0.0, 0.27, 0.44)	(0.0, 0.18, 0.27)	(0.0, 0.22, 0.75)	(0.0, 0.24, 1.0)	(0.0, 0.62, 1.0)	(0.0, 0.29, 0.65)	(0.0, 0.15, 1.0)
Axis Banking & PSU Debt	(0.0, 0.18, 0.27)	(0.0, 0.06, 0.09)	(0.0, 0.10, 0.75)	(0.0, 0.16, 0.57)	(0.0, 0.57, 0.78)	(0.0, 0.29, 0.65)	(0.0, 0.15, 1.0)

Fund							
Bandhan Banking & PSU Debt Fund	(0.0, 0.27, 0.36)	(0.0, 0.18, 0.21)	(0.0, 0.10, 0.75)	(0.0, 0.24, 0.43)	(0.0, 0.57, 0.78)	(0.0, 0.29, 0.65)	(0.0, 0.15, 1.0)
DSP Banking & PSU Debt Fund	(0.25, 0.36, 0.44)	(0.0, 0.12, 0.16)	(0.0, 0.22, 0.75)	(0.0, 0.40, 0.43)	(0.0, 0.78, 1.0)	(0.0, 0.20, 0.50)	(0.0, 0.15, 1.0)
HDFC Banking & PSU Debt Fund	(0.0, 0.09, 0.18)	(0.0, 0.18, 0.21)	(0.0, 0.12, 0.75)	(0.0, 0.20, 0.43)	(0.0, 0.78, 1.0)	(0.0, 0.35, 0.78)	(0.0, 0.15, 1.0)
HSBC Banking and PSU Debt Fund	(0.5, 0.64, 0.72)	(0.9, 1.0, 1.0)	(0.0, 0.0, 0.75)	(1.0, 1.0, 1.0)	(0.0, 0.0, 0.5)	(0.0, 0.35, 0.78)	(0.0, 0.15, 1.0)
ICICI Prudential Banking & PSU Debt Fund	(0.0, 0.27, 0.36)	(0.0, 0.0, 0.18)	(0.0, 0.44, 0.75)	(0.0, 0.16, 0.43)	(0.0, 0.0, 0.5)	(0.0, 0.29, 0.65)	(0.0, 0.15, 1.0)
Kotak Banking and PSU Debt Fund	(0.0, 0.18, 0.27)	(0.0, 0.0, 0.0)	(0.0, 0.0, 0.75)	(0.0, 0.16, 0.43)	(0.0, 0.0, 0.5)	(0.0, 0.29, 0.65)	(0.0, 0.15, 1.0)
LIC MF Banking & PSU Fund	(0.0, 0.18, 0.27)	(0.0, 0.12, 0.12)	(0.0, 0.10, 0.75)	(0.0, 0.16, 0.43)	(0.0, 0.0, 0.5)	(0.0, 0.29, 0.65)	(0.0, 0.15, 1.0)
Nippon India Banking & PSU Debt Fund	(0.0, 0.18, 0.27)	(0.0, 0.0, 0.12)	(0.0, 0.0, 0.75)	(0.0, 0.16, 0.43)	(0.0, 0.0, 0.5)	(0.0, 0.29, 0.65)	(0.0, 0.15, 1.0)
SBI Banking and PSU Fund	(0.0, 0.27, 0.36)	(0.0, 0.12, 0.15)	(0.0, 0.0, 0.75)	(0.0, 0.24, 0.43)	(0.0, 0.0, 0.5)	(0.0, 0.0, 0.5)	(0.0, 0.15, 1.0)
Sundaram Banking & PSU Fund	(0.0, 0.36, 0.45)	(0.0, 0.12, 0.15)	(0.0, 0.0, 0.75)	(0.0, 0.24, 0.43)	(0.0, 0.0, 0.5)	(0.0, 0.0, 0.5)	(0.0, 0.15, 1.0)

The normalized matrix for Banking and PSU debt funds elucidates key performance and risk characteristics, revealing that most schemes have moderate volatility, with standard deviations typically ranging from (0.0, 0.27, 0.44), indicating return stability.

Notably, HSBC has higher volatility (0.5, 0.64, 0.72) and beta values (0.9, 1.0, 1.0), indicating increased market sensitivity and an aggressive risk profile. While Sharpe ratios reflect a range of risk-adjusted returns, with certain funds, such as ICICI Prudential, showing encouraging statistics (up to 0.44, 0.75), others show insufficient risk compensation. Jensen's alpha shows that HSBC outperforms in terms of excess returns, and Treynor ratios support this trend by emphasizing its superior systematic risk-adjusted performance. With relatively low expense ratios improving their appeal and significant AUM figures signalling investor confidence.
The determined weights for each criterion represent their relative importance in the evaluation framework used to measure investment performance. The Sharpe Ratio appears as the most important indicator, with a weight of around 0.222, emphasizing its importance in balancing risk and reward. Jensen's Alpha and Treynor's Ratio, with a weighting of 0.194 and 0.167 respectively, are crucial in assessing both relative performance to a benchmark and return per unit of systematic risk. The average 10-year return, which carries a weight of 0.139, underscores the significance of past success as a guide for future investment selections. Meanwhile, Beta, Standard Deviation, AUM, and Expense Ratio have been assigned weights that have decreased cumulatively, indicating that even though each plays a part in the final rating, they are subservient to the performance-focused metrics. This hierarchically weighted approach therefore allows the creation of differentiated interpretation of the investment alternatives, thereby guiding the direction of investment decisions based on simple key performance indicators critical to maximizing investor returns while efficiently dealing with risk.
The aggregate scores for the Banking and PSU debt funds, as outlined below, are based on the following top five performers, in order:

1. Bandhan Banking & PSU Debt Fund possesses high Jensen's Alpha, hence promises a prospect for more than market returns and excellent performance indicators.
2. DSP Banking & PSU Debt Fund: The fund provides competitive, risk-adjusted returns, which demonstrate its success in risks management, and profits making.
3. HDFC Banking and PSU Debt Fund: HDFC offers spectacular balanced return, achieving such an outstanding risk-reward profile that, it is a very reliable product for investors.
4. ICICI Prudential Banking & PSU Debt Fund has performed well, which shows good management and subsequent scope for growth in the industry.
5. Sundaram Banking & PSU Fund ranks fifth and has an aggregate score going well with it.

It is a good fund for stability with acceptable return.
The rankings pose a critical need for a sophisticated assessment of risk and return measures to guide informed investment decisions in the banking and public sector.

5. LIMITATIONS OF THE PAPER

- Lack of Qualitative Appraisals: almost exclusively used quantitative measurements, so we could not derive much insight from market movements and investor mood.
- Only Five Years Time-span: The analysis of the performance data only covered a five-year time span, and therefore we were limited into just the depth of insights that we could gather.

There are other important variables not included in this model that could affect performance, for example, growth of the GDP, inflation, and interest rates. Macroeconomic Variables Excluded.

- Methodology Subjectivity: Their findings could be affected, perhaps even in terms of ranks and repeatability, due to the subjectivity introduced by using fuzzy AHP and MCDM.

6. CONCLUSION & DISCUSSION

This study gives a comprehensive and in-depth analysis of the financial characteristics of public sector firms and mutual fund schemes, which clearly brings out the gigantic and huge difference in the performing indicators and underlines the need for a detailed investment appraisal. EPS and ROE of BEML Ltd are quite strong, whereas the ITI shows negative indicators; quite clearly bring out the colossal operational problems that lead to taking the service seriously with deep financial analysis. The utilization of fuzzy logic, in conjunction with the methodology of pairwise comparison, facilitates a systematic decision regarding the relative importance of key financial indicators so stakeholders may make better strategic decisions.
Banking and PSU mutual fund scheme research shows an array of risk and return profiles. ICICI Prudential works well for a strong contender based upon great Sharpe and Treynor ratios that indicate good procedures in place for risk management. Its hierarchical framework of evaluation points out performance-centric measures to a large extent and asks investors to keep in mind the attention of their risk-adjusted returns keeping their specific risk tolerance levels at bay.

Other future research that extends from this research involves qualitative judgments, besides incorporating macroeconomic data and market sentiment indicators, into the framework to generate a more holistic investment framework. A larger dataset encompassing a wider range of organizations and mutual funds could strengthen and generalize the findings. Besides, longitudinal studies, which track the performance of specific stocks and funds over successive periods of time, would also give interesting information on the long-term sustainability of their financial health and growth rate.

Advanced machine learning algorithms to project the real-time performance of stocks and funds based on historical data and current market patterns may provide real-time insights with flexible strategies responding to changing market conditions. On their own, the impact of regulatory amendments to the performance of public sector firms and mutual funds can offer better understanding regarding the intricacies of the sector.

Finally, continuous research efforts in these directions would help bring more refined investment strategies and decision-making processes to the investors working through the intricacies of public sector investments, making the capital allocation more resilient and with better information.

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