A Systematic Literature Review on Multi-Criteria Decision Analysis and Machine Learning for Decision-Making in Digital Payment Investment

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Abstract. The growth of financial technology has strengthened the role of digital payments in driving the digital economy and influencing investment decision-making. This development creates both opportunities and challenges for investors in evaluating digital payment investments. Multi-Criteria Decision Analysis (MCDA) supports structured evaluation across multiple criteria, while Machine Learning (ML) enhances predictive capabilities using historical and market data. However, studies integrating MCDA and ML remain limited and unsystematic. This study conducts a systematic literature review (SLR) based on the PRISMA framework, analyzing publications from 2019 to 2024 related to the application of MCDA and ML in digital payment investment and decision-making. The results indicate an increasing research trend, with commonly applied MCDA methods such as AHP, TOPSIS, and PROMETHEE, and ML algorithms including Support Vector Machine and Gradient Boosting. This review identifies research gaps and provides directions for future studies and practical investment strategies in the digital payment sector.

Keywords: *Digital Payment; Investment; MCDA; Machine Learning; Systematic Literature Review.*

1. Introduction

The growth of financial technology (fintech) is rapidly accelerating, especially in driving the shift from traditional payment systems to digital methods [1] .Various innovations such as e-wallets, QR codes, mobile payments, and other digital wallets have transformed the way people conduct transactions [2]. Digital payments streamline transactions while introducing new regulatory, security, technological, and investment evaluation challenges in the digital finance ecosystem [3]. As digital payment ecosystems continue to evolve in complexity, conventional evaluation methods that rely on a single criterion are no longer adequate to fully address the diverse risks and potential benefits involved [4]. As a result, the adoption of data-driven and multi-criteria decision-making approaches is becoming increasingly essential for guiding investment strategies, strengthening risk control, and promoting long-term sustainability in digital financial services [5]. In this setting, investors need a structured approach to assess digital payment investments by considering risks, returns, technological robustness, and changing market conditions. [6]. One relevant approach in the investment decision making process is Multi- Criteria Decision Analysis

(MCDA) [7]. This method allows for quantitative evaluation of various investment alternatives based on a number of interacting criteria [8]. Furthermore, the development of Machine Learning (ML) also offers significant opportunities to assist the evaluation and decision-making process [9]. Through analysis of historical data and market trends, ML algorithms can predict user behavior, detect potential fraud, and even assess the financial performance of digital payment platforms [10]. Several previous studies have demonstrated the use of MCDA in selecting digital payment methods [11]. Most studies focus on non-financial e-wallet factors, while ML predicts behavior and detects fraud [12]. Gao et al. (2024) note ML and deep learning dominate financial applications, but few studies combine MCDA and ML for digital payment investment decisions [13]. This study addresses gaps in MCDA–ML integration and data coverage through a PRISMA-based review of 2019–2024 Scopus publications, mapping methods, integration patterns, and future research trends. Previous research has extensively explored the application of Multi-Criteria Decision Analysis (MCDA) and Machine Learning (ML) within digital payment systems. However, these approaches have generally been examined as separate methodologies rather than as integrated decision-support tools. Most studies employ MCDA to evaluate investment alternatives based on multiple decision criteria, while ML is primarily utilized for predictive modeling, classification, fraud detection, and user behavior analysis. Consequently, only a small proportion of the literature investigates the integration of MCDA and ML within a unified framework, leaving the potential synergy between these methods insufficiently understood in the context of digital payment investment. To overcome this limitation, the present study conducts a Systematic Literature Review (SLR) in accordance with the PRISMA 2020 guidelines, synthesizing evidence from publications issued between 2019 and 2024. In addition to examining publication trends, this review systematically analyzes the relationship between MCDA techniques and ML algorithms, categorizes existing hybrid approaches, and identifies methodological challenges that constrain their practical application. The primary contribution of this study is the provision of a comprehensive synthesis that reveals current research patterns, uncovers important gaps in the literature, and proposes a structured research agenda to support the future development of integrated MCDA–ML frameworks for digital payment investment decision-making.

2. Methods

2.1. Research Design

This study employs a Systematic Literature Review (SLR) methodology following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA 2020) guidelines. To ensure the rigor and reliability of the review process, this study was conducted in accordance with the PRISMA 2020 guidelines, which provide a structured and transparent framework for identifying, screening, assessing eligibility, and selecting relevant studies. Prior to the literature search, a review protocol was developed that defined the research questions, search strategy, database selection, eligibility criteria, and data extraction procedures. Establishing these procedures in advance helped reduce selection bias while enhancing the transparency, consistency, and reproducibility of the systematic review. The SLR approach was adopted to systematically identify, screen, assess, and synthesize relevant literature on the application of Multi-Criteria Decision Analysis (MCDA) and Machine Learning (ML) in digital payment investment. By applying predefined inclusion and exclusion criteria, this method ensures a transparent, rigorous, and reproducible review process.

2.2. Data Sources

The literature search was conducted using three widely recognized academic databases: Scopus, Google Scholar, and Semantic Scholar. The search was limited to English-language publications published between 2019 and 2024. Eligible sources included peer-reviewed journal articles, conference proceedings, and review papers that addressed the application of MCDA, Machine Learning, or both within the context of digital payment investment and related financial decision-making. The literature search was systematically conducted across Scopus, Google Scholar, and Semantic Scholar using predefined search

strings. A comprehensive search strategy was developed by combining keywords related to digital payment investment**,** Multi-Criteria Decision Analysis (MCDA)**,** and Machine Learning (ML) with Boolean operators to maximize the retrieval of relevant studies. The primary search string was defined as follows: ("digital payment" OR "electronic payment" OR "e-wallet" OR fintech) AND ("investment" OR "investment decision") AND ("Multi-Criteria Decision Analysis" OR MCDA OR AHP OR TOPSIS OR PROMETHEE OR VIKOR) AND ("Machine Learning" OR "Artificial Intelligence" OR SVM OR "Random Forest" OR "Deep Learning"). To accommodate differences in database functionalities, the search syntax was refined for each database while preserving the same search concepts and selection criteria, thereby ensuring consistency and comprehensiveness throughout the literature retrieval process. The scope of this review was restricted to studies published between 2019 and 2024, as this period represents a phase of significant growth in digital payment technologies, rapid advancements in financial technology (fintech), and the widespread adoption of artificial intelligence–driven decision-support systems amid global digital transformation. In addition, this timeframe encompasses the most recent methodological developments in both Multi-Criteria Decision Analysis (MCDA) and Machine Learning (ML), ensuring that the synthesized evidence provides an up-to-date representation of current research on digital payment investment.

2.3. Eligibility Criteria

The study included peer-reviewed journal articles indexed in Scopus that were published between 2019 and 2024. Eligible studies applied MCDA, Machine Learning, or related analytical methods to digital payment systems, e-wallets, or digital payment investment, and reported empirical findings in full-text English publications. Studies were excluded if they consisted of grey literature, non-peer-reviewed publications, duplicate records, articles unrelated to digital payment investment, studies that did not employ MCDA or Machine Learning methods, publications released before 2019, non-English articles, incomplete manuscripts, or narrative reviews lacking a systematic methodology. The eligibility criteria were defined prior to the screening stage to ensure a consistent study selection process and to reduce the risk of selection bias. Each retrieved study was assessed according to predefined criteria, including publication type, year of publication, language, research scope, methodological approach, and the availability of a complete full-text article.

2.4. Study Selection Process

The study selection process followed the PRISMA 2020 framework. The initial search was conducted using predefined keywords related to digital payment investment, Multi-Criteria Decision Analysis, and Machine Learning across the selected databases. After removing duplicate records, the remaining studies underwent a sequential screening process based on their titles, abstracts, and full-text content according to the established eligibility criteria. Relevant information was subsequently extracted from the eligible studies for qualitative synthesis. The complete study selection procedure is illustrated in Figure 1.

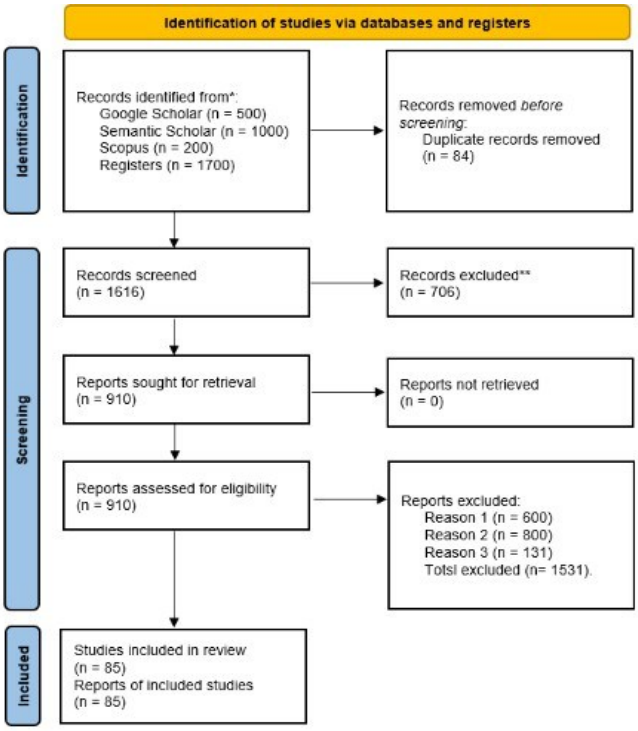


Figure 1. PRISMA Flow Diagram of Study Selection Process

Figure 3 shows ML (SVM 12%, Random Forest 11%, Gradient Boosting 9%) and MCDA (TOPSIS 47%, AHP 29%) dominance, indicating a preference for simple, interpretable methods for large digital payment datasets.

2.5. Data Extraction

For each study that met the eligibility criteria, relevant information was systematically collected using a standardized data extraction template. The extracted information included the publication year, authors, country of origin, research objectives, application domain, MCDA techniques, Machine Learning algorithms, datasets, evaluation metrics, principal findings, and reported research limitations. These data were subsequently synthesized to facilitate qualitative interpretation and comparative analysis across the selected studies.

2.6. Data Analysis

The data analysis was structured around four predefined research questions (RQs) designed to systematically examine the existing literature. RQ1 explored the application of Multi-Criteria Decision Analysis (MCDA) methods and assessed their roles in digital payment investment decision-making. RQ2 examined the use of Machine Learning (ML) by identifying the algorithms employed, data sources, analytical objectives, and reported outcomes. RQ3 investigated studies that combined MCDA and Machine Learning, focusing on their contributions to improving investment evaluation and decision-making processes. RQ4 analyzed publication trends while identifying key research challenges, methodological limitations, and gaps in the existing literature. The selected studies were synthesized using a descriptive narrative approach, enabling a comprehensive comparison of research methodologies, major findings, application domains, and future research opportunities.

2.7. Validity and Reliability

To enhance the validity and reliability of the review, only high-quality studies published in reputable peer-reviewed journals were considered. Priority was given to articles indexed in Scopus and other recognized academic databases to ensure the credibility of the included evidence. The entire review process was conducted in accordance with the PRISMA 2020 guidelines, promoting methodological transparency, consistency, and reproducibility. Furthermore, each stage of the screening and selection process was systematically documented, with explicit reasons provided for the exclusion of studies that did not satisfy the predefined eligibility criteria.

3. Results and Discussions

3.1. Publication Trends and Research Distribution

The review covered 85 publications from 2019 to 2024, showing a notable increase in studies after 2020 with the highest output in 2022. Most contributions came from Asian countries, with European nations as secondary contributors, indicating that developing regions play a central role in research on MCDA and machine learning for digital payment investment. According to Figure 2, machine learning methods account for the largest share of studies (47%), followed by MCDA (30%) and hybrid MCDA–ML approaches (9%), highlighting the expanding use of ML for predictive investment analysis [15]. MCDA is still widely used, and although MCDA–ML integration appears in only 9% of studies, it signals a growing shift toward combining quantitative and computational approaches for digital investment optimization [16].

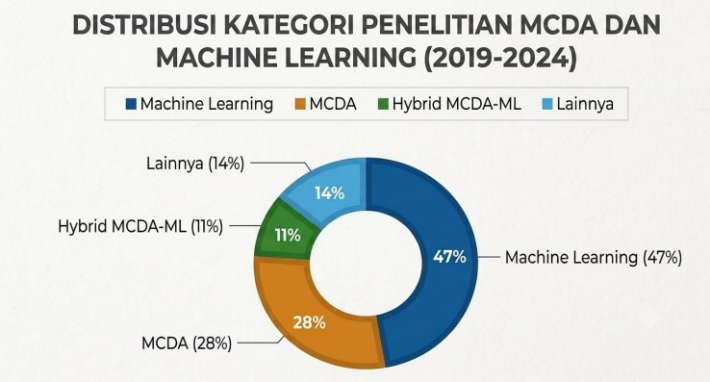


Figure 2. Distribution of MCDA and Machine Learning Research Categories (2019-2024)

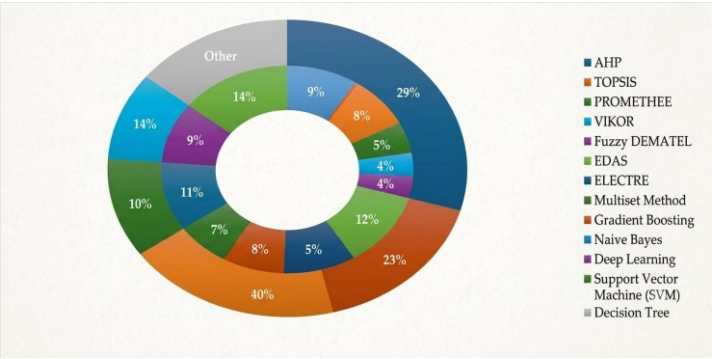


Figure 3. Classification of MCDA-Machine Learning Methods and Algorithms in Inclusion Studies (2019-2024)

Figure 3 highlights the frequent use of SVM, Random Forest, Gradient Boosting, and TOPSIS, indicating a tendency toward transparent and easily interpretable techniques. The results further suggest that

combining MCDA with machine learning is gaining momentum in digital payment investment research, as it enhances both objectivity and predictive capability in evaluation processes.

3.2. Publication Trends and Research Distribution

This section maps the findings of the 85 articles to the four RQs to identify research directions, dominant methods, and gaps in optimizing digital payment investments using MCDA and Machine Learning (ML).

3.3. Trends and Dominance of Methods

The publication trend analysis identifies how research on integrating MCDA and Machine Learning for digital payment investment optimization has developed over the past five years [17]. This analysis examines the methods and algorithms used in studies and their application in investment decisions, risk evaluation, and financial performance prediction [18]. Furthermore, this publication trend is very helpful in assessing the direction of integration between MCDA and *Machine Learning* methods, which to date remains relatively limited in the field of digital technology finance [19]. The following table maps the distribution of research methods in the included.

Table 1. Mapping Based on Research Questions

RQ & Focus	Relevant Articles	Dominant Method/ Algorithm	Main Findings
RQ1 – What MCDA methods are used in research related to optimizing digital payment investment and how effective are they?	Relevant Articles: [20]; [21]; [22]; [23]; [24]; [25]; [26]; [27]; [28]; [29]; [30]; [31]; [32]; [33]; [34]; [35]; [36]; [37]; [38]; [39]; [40]; [41]; [42].	AHP, TOPSIS, PROMETHEE	Studies show AHP and TOPSIS are most used to assess digital payment investment, effectively integrating quantitative and qualitative criteria, especially for e- wallet value and stability
RQ2– How is machine learning applied in the context of evaluating or predicting digital payment investment?	Relevant Articles: [43]; [44]; [45]; [46]; [47]; [48]; [49]; [50]; [51]; [52]; [53]; [54]; [55]; [56]; [57]; [58]; [59]; [60]; [61]; [62]; [63]; [64]; [65]; [66]; [67]; [68]; [69]; [70].	SVM, Random Forest, Gradient Boosting, Neural Network	ML is widely used for trend prediction, sentiment analysis, and anomaly detection, with SVM and Gradient Boosting leading due to their accuracy in e-wallet investment predictions.
RQ3 – Are there studies integrating MCDA and Machine Learning in optimizing digital payment investment?	Relevant Articles: [71]; [72]; [73]; [74]; [75]; [76]; [77]; [78]; [79]; [80]; [81]; [82]. Relevant Articles: [83]; [84]; [85];	Hybrid MCDA- ML (AHP-SVM, TOPSIS- Random Forest, PROME THEE-Gradient Boosting)	Integration of MCDA and Machine Learning has increased since 2021, particular ly for predictive decision modeling. This hybrid approach improves analytical objectivity butremains

RQ & Focus	Relevant Articles	Dominant Method/ Algorithm	Main Findings
RQ4 – What are the trends, challenges, and research gaps in this topic?	[86]; [87]; [88]; [89]; [90]; [91]; [92]; [93]; [94]; [95]; [96]; [97]; [98]; [99]; [100]; [101]; [102]; [103]; [84].	Trend analysis, systematic, mapping, bibliometric	AI integration in investment decisions has risen since 2021, but gaps remain due to limited datasets, inconsistent parameters, and lack of an integrative framework.

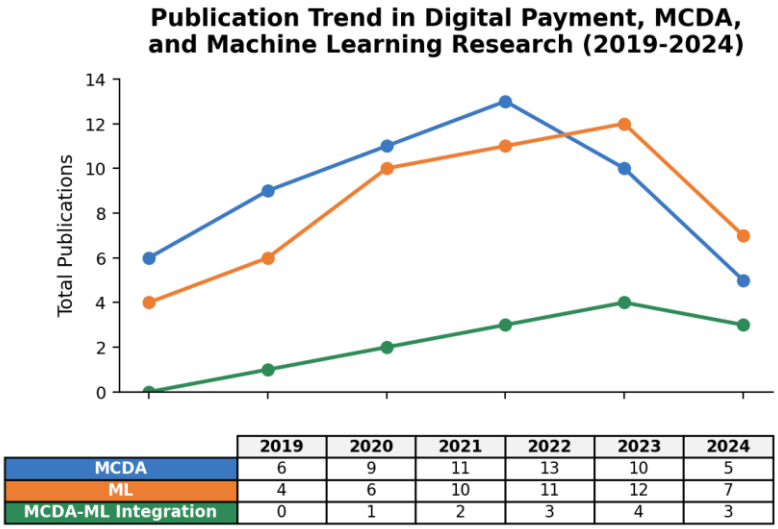
Research is dominated by MCDA and ML, with few integrations; focus is on risk and consumer perceptions, not empirical ML [104]. The analysis highlights strong potential for hybrid MCDA–ML models, combining criteria analysis and predictive power, aligning with the global shift toward data-driven fintech investment decisions [105].

Table 2. Distribution of Research Methods

Method/Algorithm	Relevant Articles	Percentage	Main Application
AHP (Analytic Hierarchy Process)	[41]; [20]; [72]; [50]; [55]; [59]; [78]	8,2%	Setting investment criteria and prioritizing digital assets.
TOPSIS (Technique for Order Preference by Similarity to Ideal Solution)	[69]; [45]; [85]; [26]; [92]; [63]	7.0%	Ranking digital payment investment alternatives and transaction efficiency
PROMETHEE	[42]; [83]; [53]; [96]	4.7%	Multi- criteria evaluation of financial technology investment risks
VIKOR	[46]; [51]; [57]	3.5%	Optimal decision- making for digital payment portfolios
SAW (Simple Additive Weighting)	[22];[74];[89]; [91]	4.7%	Evaluating digital wallet performance and usage efficiency
SVM (Support Vector Machine)	[68];[19];[80]; [48];[75];[90]; [97]	8.2%	Sentiment classification and prediction of digital payment investment trends
Gradient Boosting	[43];[71];[24]; [56];[60];[66]	7.0%	Prediction of investment performance and financial risks in digital payments
Random Forest	[18];[44];[47]; [49];[52];[54]; [54]	8.2%	Analysis of factors influencing digital payment investment iinterest
Naïve Bayes	[82];[88];[32]	3.5%	Prediction of digital payment market trends and behavior
Deep Learning (ANN, CNN, LSTM)	[70];[21];[23]; [87];[29];[35]	7.0%	Optimizing investment decisions via combined criteria and predictive modeling

Method/Algorithm	Relevant Articles	Percentage	Main Application
Integration of MCDA and Machine Learning	[81];[86];[28]; [59];[77];[62]; [98];[67]	9.4%	Optimizing investment decisions via combined criteria and predictive modeling
Fuzzy AHP, DEMATEL, MCDM	[40];[17];[73]; [27];[30];[33]; [34];[36];[81]	12.8%	Hybrid approach for investment decision-making and risk analysis

From the 85 articles, classic MCDA methods like AHP and TOPSIS still dominate (~20%), while ML usage has grown since 2021, especially SVM, Random Forest, and Gradient Boosting for predicting market sentiment and investment risk [106]. MCDA–ML integration is only 9.4%, showing a clear gap. Most use AHP/TOPSIS with ML. Publications surged in 2020–2023, peaking in 2022, marking a move toward hybrid, data-driven approaches



	2019	2020	2021	2022	2023	2024
MCDA	6	9	11	13	10	5
ML	4	6	10	11	12	7
MCDA-ML Integration	0	1	2	3	4	3

Figure 4. Trend Graph of Research Publications on Digital Payment, MCDA, and Machine Learning (2019–2024)

3.4. Thematic Discussion and Insight (MCDA- Machine Learning Integration & Research Gap)

1. As shown in Figure 4, MCDA and Machine Learning have increasingly been used (2019–2024) to optimize digital payment investments. MCDA supports evaluating multi- criteria factors like risk, returns, platform reliability, and user adoption [107]. Machine Learning builds predictive models from historical data and market trends. Integrating MCDA and ML provides a more comprehensive, data-driven framework for decision-making in digital finance [104].

Table 3. MCDA–Machine Learning Integration in Digital Payment Research

Main Theme	Integrated Methodologies (MCDA & ML)	Relevant Articles	Main Objective/Application
Digital payment investment evaluation	MCDA: AHP, TOPSIS ML: Gradient Boosting, SVM	[18], [21], [23],[54], [91]	Assessing investment feasibility and predicting e- wallet platform stock performance

Main Theme	Integrated Methodologies (MCDA & ML)	Relevant Articles	Main Objective/Application
Fintech portfolio optimization	MCDA:PROMETHEE, VIKOR, ML: Random Forest, XGBoost.	[19], [20], [75], [88], [31]	Optimizing investment allocation across digital payment platforms
Transaction risk & security analysis	MCDA: ANP, SAW ML: Logistic Regression, Decision Tree	[22], [24], [28], [61]	Detecting transaction risks and potential fraud in e-payment systems
Consumer adoption prediction	MCDA:TOPSIS, ELECTRE ML: Neural Network, Naïve Bayes	[43], [72], [82], [89], [63]	Modeling consumer behavior towards e- wallet adoption
Macro policy and investment integration	MCDA: AHP, PROMETHEE ML: K-Means, Deep Learning	[70], [51], [58], [35], [79]	Macroeconomic analysis and national digital payment investment policy

2. Insights from the Integration of MCDA and Machine Learning
As shown in Table 3, combining MCDA with machine learning yields key advantages in investment decision-making. The hybrid framework improves accuracy by integrating MCDA's evaluation of qualitative factors with machine learning's capacity to extract complex patterns from large-scale data. Moreover, it enhances adaptability by allowing criteria weights to be updated dynamically based on real-time market information.[108]. However, despite these advantages, MCDA– Machine Learning integration remains very limited, mostly confined to simulation studies, with few real-world implementations—especially within Southeast Asian financial institutions. [109].

3.5. Research Gaps and Future Research Directions

The results of the synthesis and analysis conducted from the 85 included studies revealed several significant research gaps, the findings of which are presented in Table 4 below.

Table 4. Research Gaps and Future Research Direction

Analyzed Aspect	Research Gap	Potential Future Research Direction
Integration of MCDA–Machine Learning	Only 12 studies (around 14%) integrate both methods.	Hybrid models combining MCDA and ML using real-time financial data.
Application Domain	Focus remains mostly on Asia, especially India.	Expansion to European and African markets.
Model Validation	Overall, most Studies are simulation-based only.	The need for empirical experiments using actual transaction data in the e-wallet context.

Analyzed Aspect	Research Gap	Potential Future Research Direction
Social & Ethical Aspects	Most studies offer little on AI ethics and data privacy.	Ethical AI principles should be incorporated into investment forecasting models.
Publication	Only 4 studies are published in Scopus Q1 journals	More reputable studies are needed to strengthen MCDA–ML in digital payment investment.

MCDA–ML integration has strong potential for smarter digital payment investments, but limited validation and low standardization remain challenges. Future work should focus on adaptive hybrid systems.

3.6. Knowledge Contribution and Research Gaps in MCDA–Machine Learning Integration

The findings of this review indicate that the existing research gap is not solely reflected in the limited number of studies integrating Multi-Criteria Decision Analysis (MCDA) and Machine Learning (ML). More critically, the available hybrid studies reveal considerable methodological inconsistency and fragmentation. In most cases, MCDA and ML are applied independently or integrated only at isolated stages of the decision-making process, without establishing a unified framework that systematically connects criteria weighting, predictive modeling, and investment evaluation. Moreover, empirical validation based on real-world digital payment datasets remains limited, reducing the practical relevance, robustness, and generalizability of the proposed approaches. The primary contribution of this review is the systematic synthesis of these methodological patterns into a coherent body of knowledge that clarifies the current state of research on MCDA–ML integration in digital payment investment. Based on the evidence gathered from the selected studies, this review identifies three key priorities for future research: (1) the design of comprehensive MCDA–ML decision-support frameworks, (2) the integration of dynamic, real-time financial and transactional data into hybrid analytical models, and (3) rigorous empirical validation across diverse digital payment environments. Collectively, these findings establish a stronger conceptual foundation and provide practical guidance for future research aimed at developing intelligent, data-driven decision-support systems for digital payment investment.

3.7. Comparative Analysis of MCDA and Machine Learning Methods

The reviewed studies demonstrate that Multi-Criteria Decision Analysis (MCDA) and Machine Learning (ML) offer complementary capabilities for digital payment investment decision-making. MCDA methods, particularly AHP and TOPSIS, provide structured frameworks for evaluating multiple decision criteria and ranking investment alternatives. However, their effectiveness depends on expert judgment and predefined criteria weights, which may introduce subjectivity into the decision-making process. In contrast, ML algorithms such as Support Vector Machine (SVM), Random Forest, and Deep Learning are effective for prediction, classification, and pattern recognition, although their performance depends on data quality and model interpretability. A critical analysis of the literature indicates that most studies evaluate MCDA and ML independently rather than through direct methodological comparison or integrated implementation. Consequently, limited evidence exists regarding the relative effectiveness of different analytical approaches or their combined application in digital payment investment. This methodological fragmentation highlights the need for more comprehensive comparative studies and integrated decision-support frameworks that combine the transparency of MCDA with the predictive capabilities of ML. The findings of this review contribute by providing a critical synthesis of the

strengths, limitations, and complementary roles of MCDA and ML. They also identify important research opportunities, including the development of integrated hybrid frameworks and the validation of these approaches using real-world digital payment datasets to improve the reliability and applicability of investment decision-support systems.

4. Conclusion

This systematic literature review, guided by PRISMA 2020, analyzed 85 studies published between 2019 and 2024 on the use of Multi-Criteria Decision Analysis (MCDA) and Machine Learning (ML) in digital payment investment decision-making. Research in this area is growing steadily, concentrated mainly in Asian countries, with MCDA methods such as AHP, TOPSIS, and PROMETHEE dominating structured evaluation while ML algorithms like SVM, Random Forest, and Gradient Boosting are mainly used for prediction, fraud detection, and behavioral analysis. However, integration of the two approaches remains limited to only 9–14% of studies and is largely confined to simulation-based settings rather than real-world validation. This review contributes a critical synthesis of the complementary strengths of MCDA and ML and highlights key gaps, including the absence of unified frameworks, limited empirical validation, narrow geographic coverage, and insufficient attention to AI ethics and data privacy. Future research should prioritize adaptive hybrid MCDA–ML frameworks validated on real transactional data, broader cross-regional studies, and the incorporation of ethical AI principles. These directions offer a concrete agenda for building more robust and practically relevant decision-support systems for digital payment investment.

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