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Implementation of Fuzzy Delphi Method in Designing AI-Based Social Banking Model for Iranian Cooperative Banks

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ABSTRACT

Cooperative banks, due to their socially oriented nature, play a crucial role in the socio-economic development of local communities, with the expansion of new technologies, making them ideal candidates for the implementation of AI-based social banking. Despite extensive literature on social banking and AI applications separately, there is a significant research gap regarding comprehensive models that specifically integrate AI functionalities with social banking principles in cooperative banking contexts. Furthermore, previous studies have not adequately addressed the specific conditions of developing countries such as Iran, especially considering unique challenges such as international sanctions and local economic constraints. This study adopted a two-stage qualitative approach. First, we systematically reviewed 36 academic articles published between 2014 and 2024 using a meta-synthesis methodology to identify initial dimensions and constructs. Second, we used the Fuzzy Delphi method with 15 banking industry experts to validate and localise the model through three rounds of evaluation, using a 0.7 threshold for final component acceptance. The research results led to the identification of 9 main dimensions and 56 components, with defuzzified values ranging from 0.719 to 0.881. The dimensions include AI technology and infrastructure, social development and community empowerment, financial and economic aspects, management and strategy, legal and regulatory framework, banking products and services, customer centricity, risk and security, and sustainability. Quantitative analysis revealed that components such as localisation of AI technologies (0.754), empowerment of female-headed households (0.769), supply chain financing (0.881), sanctions management (0.787), and alternative foreign exchange services (0.822) received the highest expert consensus, reflecting their critical importance in the Iranian banking context.

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1. Introduction

In the current era, characterized by remarkable technological advancements and digital transformation, the banking industry is undergoing fundamental changes more than ever before. The development of emerging technologies, particularly AI in the past decade, has not only revolutionized banks' operational methods but has also challenged traditional banking concepts. This profound transformation stems from technical advances in areas such as machine learning, natural language processing, and big data analytics on one hand, and from generational shifts in customer expectations and new demands for banking services on the other. In this turbulent environment, banks must embrace and implement these technologies to maintain their competitive advantage; otherwise, they risk losing market share to more agile and technologically advanced competitors.

Changes in banking customer expectations and behaviors have also emerged as a powerful driver, pushing banks to revise their traditional business models. Today's customers demand personalized services, 24/7 accessibility, seamless user experience, and social value addition [37]. In response to these emerging needs, the concept of social banking has gained increasing importance as an innovative approach that intelligently combines economic objectives with social responsibilities. This approach seeks to create sustainable value for all stakeholders and society beyond mere profitability [40].

In this context, cooperative banks, due to their people-centered and social nature, have unique potential to pioneer in intelligent social banking. These banks, established to promote local economic and social development, play a vital role in microfinance, supporting small and medium enterprises, and empowering underprivileged segments of society. Extensive studies demonstrate that cooperative banks, compared to commercial banks, possess distinct advantages: lower systematic risk, better asset quality, greater focus on financing the local real economy, and closer customer relationships [41]. These characteristics make cooperative banks an ideal platform for implementing innovative social banking models.

However, cooperative banks face numerous challenges that affect their competitive capability. Limited financial and human resources, lack of access to advanced technologies, weak technical infrastructure, increasing competition from FinTechs and neobanks, and regulatory complexities are among these challenges. Additionally, international sanctions and Iran's specific economic conditions have added another layer of complexity to these challenges.

A systematic review of the literature reveals that numerous studies have been conducted in the fields of social banking and AI applications in banking. Mahmoodi et al. [21] examined an innovative model of social banking based on digital transformation focusing on six key factors. Rezaei [31] designed a social banking model with a post-COVID approach. Internationally, Rahman et al. [28] studied the challenges and opportunities of AI adoption in the banking industry. de Andreis et al. [7] presented an integrated approach for combining social business and AI toward sustainable development. Radhakrishna et al. [27] investigated the role of personal intelligent assistants in the future of banking knowledge management.

However, careful examination of existing literature reveals significant research gaps. First, no comprehensive and integrated model specifically addressing the integration of AI functionalities with social banking principles in the cooperative banking context has been presented. Second, previous studies have largely been conducted on a case-by-case basis without considering the specific conditions of developing countries. Third, existing research has paid less attention to the operational and implementation aspects of these models in real conditions. Fourth, domestic studies in this field have typically focused either on technical aspects of AI or solely on social dimensions, rarely taking an integrated approach.

The main objective of this research is to present a comprehensive and localized model for implementing AI-based social banking in Iranian cooperative banks. This model aims to strengthen the social nature and people-centered approach of cooperative banks while leveraging the potential of emerging technologies, providing operational solutions for addressing specific challenges in Iran's business environment.

This research offers several significant contributions that advance both theoretical knowledge and practical implementation of AI-based social banking models. First, our hybrid methodological approach represents a substantial innovation by combining meta-synthesis with fuzzy Delphi methodology. This integration allows us

to simultaneously leverage global knowledge bases while ensuring contextual relevance to Iran's specific banking environment. Unlike previous studies that typically employ single methodologies, our combined approach enhances model validity through both theoretical foundation and expert validation.

Second, the comprehensiveness of our model provides a unique contribution by simultaneously addressing technical, social, economic, regulatory, and operational dimensions of AI-based social banking. Previous models have primarily focused on either technological or social aspects in isolation, whereas our integrated framework enables cooperative banks to implement holistic transformation strategies.

Third, our research offers unprecedented contextualization by identifying and validating Iran-specific components such as sanctions management, alternative SWIFT banking services, and localization of AI technologies that are critical for developing countries operating under international restrictions. This localized approach significantly increases the model's practical applicability and implementation feasibility in similar contexts.

Finally, our quantitative fuzzy Delphi results provide empirical validation of component priorities, offering evidence-based guidance for resource allocation and strategic planning in cooperative banks. This prioritization framework represents a valuable decision-making tool that bridges theoretical models and practical implementation considerations.

The scientific contribution of this research can be explained at several levels: At the theoretical level, this research contributes to expanding existing literature in social banking and AI by providing an integrated framework that can serve as a foundation for future research. At the methodological level, the combined research approach can serve as a model for similar studies in other fields. At the practical level, this research provides operational guidance for implementing intelligent social banking.

The results of this research will be beneficial for a wide range of stakeholders: Managers and decision-makers of cooperative banks can use this model to develop their digital transformation strategies. Monetary and banking policymakers can utilize the research findings to develop supportive regulations and policies. Financial technology experts can gain a better understanding of the specific needs and requirements of cooperative banks. Researchers can use the presented framework for developing future studies.

The main research question is: What is the appropriate model for implementing AI-based social banking in Iranian cooperative banks, and what are the main dimensions and components of this model? Specifically, this research seeks to identify the most important implementable AI functions in cooperative banks, determine the required infrastructure and requirements, and provide solutions for overcoming operational challenges.

2. Literature Review

2.1. Social Banking

Social banking represents a turning point in the evolution of the banking system, emerging as a novel approach in the banking industry. This concept, formed at the intersection of two important trends - increasing public awareness of organizations' social responsibilities and evolution in banking customer expectations - has now become one of the most important discourses in finance. Andrikopoulos [3] demonstrates in his study that social banking is more than a marketing strategy; it represents a fundamental paradigm shift in how banks operate.

De Andreis et al. [7] have presented a comprehensive framework for social banking in their latest research, comprising four main pillars. First, financial inclusion, meaning the expansion of access to financial services for all segments of society, particularly underprivileged groups. Second, social empowerment, encompassing support for small businesses, social entrepreneurship, and local economic development. Third, environmental sustainability, focusing on green financing and support for environmentally friendly projects. Fourth, operational transparency, meaning accurate reporting and accountability to all stakeholders.

Stavropoulou et al. [37] examined the role of social banking in the success and continuity of small and medium enterprises. Their findings indicate that social banks, by providing services tailored to the real needs of local communities and developing a deeper understanding of business conditions, can play a significant role in

sustainable economic development. These findings are supported by Sarkar and Thapa [34], who demonstrate how social banking can help fill gaps in traditional financial systems.

2.2. Cooperative Banks

Cooperative banks, as unique financial institutions aimed at providing financial services to members and developing local economies, play a distinctive role in the banking system. Venanzi and Matteucci [41], in their comprehensive study of 253 European banks, showed that cooperative banks demonstrate greater financial stability compared to commercial banks and perform better during economic crises. This superior performance can be attributed to these banks' structural characteristics, including democratic corporate governance models, shared member ownership, and focus on long-term community benefits.

Hermawan & Rahayu [12] in their recent research have highlighted the pivotal role of cooperative banks in local communities' economic empowerment. They demonstrate that these banks contribute to socio-economic development through three main channels: providing affordable financial services, targeted support for small and medium enterprises, and implementing social development programs. These findings align with Nethala et al. [23]'s research, emphasizing that cooperative banks can provide more effective services due to their deep understanding of local needs and close customer relationships.

Korzeb et al. [20], in their bibliometric analysis of ESG performance in cooperative banks, identified 13 research clusters, indicating that these banks are increasingly moving toward integrating environmental, social, and governance considerations into their operations. Similarly, Gautam et al. [10], through their case study of Indian state cooperative banks, have shown that despite their relatively small market share, these banks will play an increasing role in the future of the banking industry due to their ability to ensure broader financial inclusion.

2.3. AI applications in banking

The digital transformation in the banking industry, centered on AI, has become a turning point in the evolution of financial services [1]. Radhakrishna et al. [27], in their comprehensive study on the future of knowledge management in investment banking, show that personal intelligent assistants can facilitate data analysis and research in managing extensive data, eliminate repetitive tasks, and provide personalized recommendations for portfolio management.

Sadok et al. [32], focusing specifically on the role of AI in credit risk analysis and assessment, predict a profound transformation in traditional credit assessment methods. They emphasize that AI-based rating models not only increase decision-making accuracy but can also have a significant impact on financial sustainability, regulatory capital of banks, financial inclusion, and economic growth.

Rahman et al. [28], in examining the challenges and opportunities of AI adoption in the Malaysian banking industry, concluded that despite significant benefits such as cost reduction and improved customer service, cultural and infrastructural barriers remain the main challenges in widespread adoption of this technology. These findings are also confirmed by Thongsri & Tripak [39], who emphasized the importance of technical and cultural readiness in their study of social banking adoption during the pandemic period.

2.4. AI-Based Social Banking

The integration of AI with social banking principles has created a new paradigm in the banking industry that can significantly increase banks' social impact [4]. de Andreis et al. [7], in their latest study titled "Social Business, AI, and Sustainability," demonstrate that strategic use of AI for resource optimization and operational efficiency improvement can play a central role in achieving sustainable development goals. They emphasize that this integrated approach effectively addresses environmental, social, and economic issues while ensuring economic sustainability.

Korzeb et al. [20], through their extensive analysis of ESG performance in cooperative banks, have provided a comprehensive framework for integrating intelligent technologies with social objectives. They demonstrate how smart algorithms can be used in identifying social investment opportunities, assessing environmental impacts, and optimizing resource allocation to maximize social impact.

Musleh Al-Sartawi et al. [22], in their research on integrating AI in ESG reporting, addressed the importance of this technology in sustainable investment decisions. They emphasize that AI can help identify ESG risks and social investment opportunities more accurately by analyzing vast amounts of data. These findings align with Iannaci & Gideon's [14] study, which demonstrates how combining emerging technologies with social finance can support the development of social enterprises.

Patel & Patel [25], in examining the barriers to digital banking services in the cooperative sector, identified specific challenges that must be considered in implementing intelligent social banking models. These challenges include technical issues, service interruptions, security, and processing costs. However, Hermawan & Rahayu [12], in their case study, have shown how technology-based corporate social responsibility programs can help empower SMEs and strengthen their management, technical, and marketing skills in local, regional, and international markets.

Jakšič & Marinč [15] emphasize the importance of maintaining balance between technological innovation and maintaining human relationships in banking. They argue that banks should not sacrifice relationship banking, which creates close connections with customers, for technological advancement. Instead, AI should be used as a tool to strengthen and deepen these relationships. This perspective is also confirmed by Sarkar and Thapa [34], who warn that the human aspect of banking relationships should not be overlooked in the digital age.

To provide a more systematic analysis of the literature and clearly identify research gaps, we have categorized existing studies based on their primary focus areas. Table 1 summarizes key literature contributions and identifies gaps in the research landscape.

Table 1. Summary of Literature and Research Gaps

Focus Area	Key Studies	Main Contributions	Limitations/Gaps
Social Banking Concepts	[3], [7], [37]	Defined social banking paradigms; Established four-pillar framework; Linked social banking to SME success	Limited integration with technological dimensions; Lack of operational implementation frameworks
Cooperative Banking Models	[12], [20], [41]	Demonstrated superior financial stability; Identified socio-economic development channels; Mapped ESG integration patterns	Insufficient attention to digital transformation challenges; Limited exploration of AI integration opportunities
AI Applications in Banking	[27], [28], [32]	Examined intelligent assistants in knowledge management; Explored AI's role in credit assessment; Identified adoption challenges	Primarily focused on commercial banking contexts; Limited consideration of social impact dimensions
AI-Social Banking Integration	[7], [20], [22]	Connected AI with sustainable development; Provided ESG integration framework; Explored AI in sustainable investment	Lack of comprehensive implementation models; Insufficient localization for developing economies; Limited empirical validation

Based on this systematic analysis, we identify four critical research gaps that our study addresses:

- Lack of Integrated Models: No comprehensive framework exists that specifically addresses the integration of AI functionalities with social banking principles in cooperative banking contexts.
- Context-Specific Limitations: Previous studies have largely been conducted on a case-by-case basis without considering the specific conditions of developing countries, particularly those facing unique challenges like international sanctions.
- Implementation Gap: Existing research has paid insufficient attention to the operational and implementation aspects of these models under real-world constraints.
- Fragmented Approach: Most domestic studies in this field have typically focused either on technical aspects of AI or solely on social dimensions, rarely taking an integrated approach that combines both perspectives.

3. Methodology

This research was conducted using a qualitative approach in two main phases. In the first phase, the meta-synthesis method was used to extract the initial dimensions and components of the model, while in the second phase, the fuzzy Delphi method was employed for model validation and localization.

In the meta-synthesis phase, Sandelowski & Barroso's [33] seven-step approach was utilized. Initially, the research question was formulated within the framework of four parameters (what, study population, time limitation, and methodology). Then, a systematic literature search was conducted in reputable international scientific databases including Elsevier, Wiley, Springer, Taylor & Francis, Emerald, and domestic databases SID, Civilica, and Magiran. Various keywords in the areas of social banking, AI in banking, and cooperative banks were used for the search, and the time period was limited to 2014-2024.

In the article refinement phase, from a total of 298 identified articles, 185 were eliminated after reviewing titles and abstracts due to lack of direct relevance to the topic. In the next stage, 77 articles were removed after full-text review and quality assessment. The Critical Appraisal Skills Programme (CASP) with 10 quality criteria was used for quality assessment, and only articles scoring above 30 (out of 50) were selected for final analysis. Ultimately, 36 articles were selected for in-depth content analysis.

In the second phase of the research, the fuzzy Delphi method was used for model validation and localization. In this phase, 15 banking industry experts were selected using purposive sampling. Expert selection criteria included mastery of cooperative banking concepts and familiarity with fourth-generation industry developments, particularly AI functions, minimum educational qualification of master's degree, and at least 15 years of relevant work experience, preferably in senior management positions. Among the selected experts, 8 held doctoral degrees and 7 held master's degrees. In terms of work experience, 6 had between 15-20 years, 5 had between 21-25 years, and 4 had over 25 years of experience in the banking industry.

In this study, we employed triangular fuzzy numbers (TFNs) for representing expert opinions in the Fuzzy Delphi process. A triangular fuzzy number is denoted as Ã = (*l*, *m*, *u*), where *l*, *m*, and *u* represent the lower bound, most likely value, and upper bound of the fuzzy number, respectively. This representation was selected due to its computational simplicity and effectiveness in capturing the uncertainty and vagueness inherent in expert judgments. The membership function $\mu_{\tilde{A}}(x)$ of a triangular fuzzy number $\tilde{A}$ is defined as:

$$\mu_{\tilde{A}}(x)=\begin{cases}0, & x \le l,\\ \dfrac{x-l}{m-l}, & l \le x \le m,\\ um, & m \le x \le u\end{cases} \quad (1)$$

where $l \leqslant m \leqslant u$, and *l* and *u* are the lower and upper bounds of the support of Ã, respectively. When *l* = *m* = *u*, it represents a crisp number. The triangular fuzzy number representation provides an intuitive framework for experts to express their judgments while incorporating the inherent uncertainty in their evaluations.

To ensure the accuracy and validity of the Delphi process, an initial questionnaire was prepared and presented to several experts to collect their feedback and identify potential issues for correction. Then, the final questionnaire was prepared based on the extracted indicators and expert opinions using linguistic variables presented in Table 2.

Table 2. Relationship between Linguistic Terms and Fuzzy Numbers

Linguistic Variable	Fuzzy Number	*l*	*m*	*u*
Very Low	(0, 0, 0.25)	0	0	0.25
Low	(0, 0.25, 0.5)	0	0.25	0.5
Medium	(0.25, 0.5, 0.75)	0.25	0.5	0.75
High	(0.5, 0.75, 1)	0.5	0.75	1
Very High	(0.75, 1, 1)	0.75	1	1

At this stage, linguistic variables were defined as triangular fuzzy numbers. Triangular fuzzy numbers were assigned to each expert's opinion, and the set of triangular fuzzy numbers for each expert was obtained using Equation (2).

$$\tilde{A}^{(i)} = (a_1^{(i)}, a_2^{(i)}, a_3^{(i)}),\ i = 1,2,3,...,n \quad (2)$$

Furthermore, to convert all expert opinions about an indicator into a single fuzzy number, the average of fuzzy sets and Equation (3) were used.

$$\tilde{A}_m = (a_{m1}, a_{m2}, a_{m3}) = (\frac{1}{n}\sum_{i=1}^{n} a_1^i, \frac{1}{n}\sum_{i=1}^{n} a_2^i, , \frac{1}{n}\sum_{i=1}^{n} a_3^i) \quad (3)$$

Finally, to defuzzify the final values for each indicator, the simple center of gravity method was used based on Equation (4).

$$S_j = \frac{u_j + m_j + l_j}{3} \quad (4)$$

To ensure methodological rigor in the fuzzy Delphi process, we utilized established approaches from the literature. The linguistic variables and corresponding triangular fuzzy numbers presented in Table 2 were adapted from Habibi et al. [11], who demonstrated the effectiveness of this scale in expert opinion aggregation. Equation (3), which defines the triangular fuzzy number set for each expert, follows the standard formulation established by Kaufmann and Gupta [18]. For the aggregation of expert opinions into a single fuzzy number in Equation (3), we employed the arithmetic mean method as suggested by Chang et al. [6]. Finally, the defuzzification process using the simple center of gravity method shown in Equation (4) was implemented following Hsieh et al. [13], who validated this approach in similar consensus-building studies.

Regarding the defuzzification method, we employed the simple center of gravity (COG) method as represented in Equation 4 due to its widespread acceptance in fuzzy Delphi studies and its computational efficiency. While several alternative defuzzification methods exist (such as mean of maxima, weighted average, or alpha-cut methods), the COG method offers a balanced representation of the fuzzy number by considering all three parameters (l, m, u). We conducted a sensitivity analysis by comparing our results with alternative defuzzification methods, including the weighted average method $S = (l + 2m + u)/4$ and found that while specific defuzzified values showed minor variations (±0.05), the relative rankings of components and the acceptance/rejection decisions using our threshold remained consistent. This robustness check confirms the appropriateness of our selected method for this research context.

The fuzzy Delphi process was conducted in three rounds. In the first round, a questionnaire containing components extracted from the meta-synthesis phase was provided to the experts. In the second round, a new questionnaire was sent along with each individual's previous opinions and their deviation from other experts' views. In the third round, only components where the difference in mean expert opinions exceeded the threshold (0.2) were reassessed. For final screening of indicators, a threshold of 0.7 was used, and components with defuzzified values below this threshold were eliminated.

To ensure research reliability and validity, multiple methods were employed. Validity was established at three levels: descriptive (through regular meetings and use of Endnote software), interpretive (continuous evaluation of findings by the research team), and practical (utilizing expert opinions). Research reliability was also measured using CASP and evaluated by two independent assessors.

4. Research Findings

The present research was conducted in two main phases, and the findings of each phase are presented separately.

4.1. Meta-synthesis Findings

In the first phase of the research, 298 scientific articles were identified using the meta-synthesis method, which after filtering and quality assessment, 36 articles were ultimately selected for in-depth analysis. The frequency distribution of articles in different scientific databases is presented in Table 3.

Table 3. Frequency of Articles in Selected Scientific Databases

Database	Initial Count	Final Count
Elsevier	82	12
Springer	65	8
Emerald	54	6
Wiley	43	4
Taylor & Francis	31	3
SID	12	2
Civilica	8	1
Magiran	3	0
Total	298	36

After coding and content analysis of the selected articles, 187 initial concepts were extracted, which were categorized into 48 components during secondary coding. Finally, these components were classified into 9 main dimensions. The details of concepts extracted from the literature review are shown in Table 4.

Table 4. Concepts Extracted from Literature Review

Concepts	Ref.
Deep neural networks, customer behavior prediction algorithms, recommender systems, image and document processing, customer clustering	[5], [7], [9], [10], [31], [32], [38], [43]
Smart chatbots, customer sentiment analysis, banking text processing, automatic document translation	[15], [22], [29], [43]
Credit risk assessment, intelligent investment advice, fraud detection, portfolio optimization, market prediction	[5], [19], [27], [38]
Cloud infrastructure, distributed processing, secure storage, scalability	[30], [39], [40], [43]
Smart ATMs, security sensors, contactless payments, digital branches	[9], [21], [24]
Customer behavior analysis, trend prediction, transaction mining, analytical reports, management dashboards, data visualization	[10], [31], [32], [42]
Financial education, support for local cooperatives, regional infrastructure development, social development programs	[16], [34], [35]
Low-interest loans, business consulting, startup facilities, business networking, innovation support	[17], [23], [37]
Educational projects, health plans, support for vulnerable groups	[3], [12], [14], [36]
Access to banking services, financial literacy, affordable financial services, coverage of deprived areas, inclusive mobile banking	[31], [37]
Employment loans, entrepreneurship training, support for innovative projects, supply chain financing, business consulting	[12], [35], [42]
Revenue management, cost control, revenue source diversification, operational efficiency, asset management	[17], [26], [41]
Process automation, energy management, branch optimization, service digitalization	[2], [19], [40], [44]
Optimal resource allocation, liquidity management, financial planning, consumption control, balance of resources and expenditures, deposit management	[10], [21], [34], [37]
Small loans, group facilities, quick-return credits, supply chain financing	[14], [30], [38]
Vision development, long-term goal setting, operational plan, key performance indicators, digital transformation roadmap	[26], [41], [42]
Organizational resistance, staff training, culture building, organizational communications, expectation management	[15], [21], [39]
Specialized training, digital skills, employee motivation, talent management	[8], [23], [24], [44]
Employee creativity, innovation culture, design thinking, open innovation, ideation, innovation management	[7], [9], [31], [36]
Transparency, accountability, organizational justice, conflict of interest management, internal controls	[3], [8], [26], [41]
Experience documentation, knowledge sharing, organizational learning, knowledge base	[27], [31], [39], [42]
Organizational values, teamwork, customer orientation, professional ethics, continuous learning	[8], [16]

Concepts	Ref.
Regulatory compliance, banking standards, supervisory reporting, capital adequacy, legal requirements	[1], [19], [22]
Information security, data confidentiality, customer privacy, access management	[15], [32], [40]
Customer identification, transaction monitoring, suspicious case reporting, authentication, transaction tracking	[19], [21], [22]
Financial reporting, information disclosure, internal audit, financial controls	[3], [8], [20], [26]
Consumer protection, complaint handling, compensation, customer education, customer rights charter	[31], [34], [37]
Mobile banking, internet banking, digital wallet, open banking, virtual branches	[21], [24], [25], [30], [39]
Investment consulting, personal financial planning, wealth management, market analysis	[9], [27], [32]
Need-based facilities, service packages, hybrid products, special customer plans	[15], [23], [31]
Mobile payment, wallet, instant payment, social commerce, automatic payment	[39], [40]
Crowdfunding, group loans, employment facilities, social microloans	[14], [35]
Joint accounts, group investment, cooperative savings, group facilities	[16], [20], [41]
Smart recommendations, need-based services, customized experience, customer personal profile, customer lifetime value	[15], [23], [31]
Integrated channels, multiple access, simple user interface, user experience design, omnichannel banking	[25], [30], [34], [39]
24/7 support, request handling, response time, service quality	[5], [21], [25], [40]
Satisfaction measurement, customer loyalty, continuous feedback, service evaluation, continuous improvement	[23], [36], [37]
Network security, infrastructure protection, cyber attack prevention, vulnerability assessment, information security	[15], [22], [32]
Encryption, two-factor authentication, security tokens, secure protocols, transaction control, real-time monitoring	[24], [25], [40]
Biometric authentication, digital signature, multi-factor authentication, digital identity	[31], [39]
Fraud detection systems, learning algorithms, behavioral analysis, early warning, fraud prevention	[19], [32]
Business continuity plan, data recovery, rapid response, crisis preparedness, operational risk management	[39], [41], [42]
Paper consumption reduction, waste management, energy consumption optimization, green building, environmental protection	[3], [7], [22], [26]
Balanced growth, fair resource distribution, regional development, financial sustainability, sustainable employment	[7], [17], [37], [41]
Equal service access, support for low-income groups, economic empowerment, gender equality	[8], [12], [34]
Green financing, environmental credits, sustainable investment, green projects	[3], [17], [20], [22]
Consumption optimization, renewable energies, building smartification, carbon footprint reduction	[21], [26], [41]
ESG criteria, ethical investment, social impact, long-term sustainability, sustainability risk assessment	[3], [14], [20], [26], [36]

In the next stage, the classification of findings led to the formation of the initial conceptual model. This initial conceptual model included 9 main dimensions: AI technology and infrastructure, social development and community empowerment, financial and economic aspects, management and strategy, legal and regulatory framework, banking products and services, customer-centricity and user experience, risk and security, and sustainability and sustainable development. The initial conceptual model resulting from meta-synthesis is shown in

Figure 1.

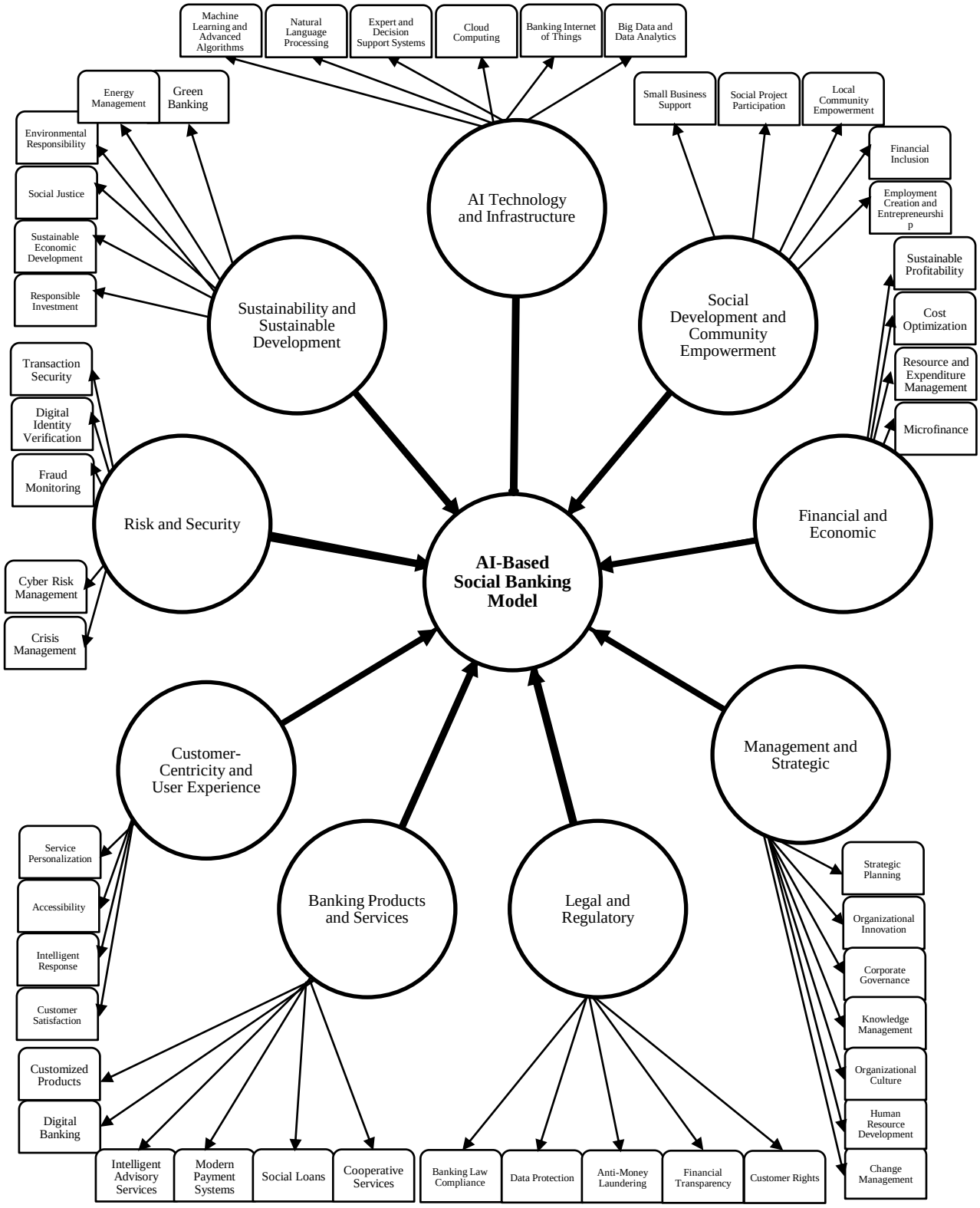

Figure 1. Initial Conceptual Model Resulting from Meta-Synthesis

4.2. Fuzzy Delphi Findings

In the second phase of the research, the model extracted from meta-synthesis was evaluated and refined through three rounds of fuzzy Delphi. In the first round, 48 identified components were presented to 15 experts, with the results shown in

Table 5. After this stage, experts suggested 13 new components, which are shown in

Table 6.

Table 5. Results of First Round of Fuzzy Delphi

Dimensions	Components	Expert Opinion Aggregation			Defuzzified Value
		l	*m*	*u*	*S1*
AI Technology and Infrastructure	Machine Learning and Advanced Algorithms	0.811	0.983	0.850	0.881
	Natural Language Processing	0.750	0.933	0.783	0.822
	Expert and Decision Support Systems	0.711	0.917	0.733	0.787
	Cloud Computing	0.383	0.417	0.367	0.389
	Banking Internet of Things	0.383	0.617	0.367	0.456
	Big Data and Data Analytics	0.667	0.883	0.683	0.744
Social Development and Community Empowerment	Local Community Empowerment	0.650	0.850	0.667	0.722
	Small Business Support	0.650	0.867	0.667	0.728
	Social Project Participation	0.694	0.900	0.717	0.770
	Financial Inclusion	0.639	0.867	0.650	0.719
	Employment Creation and Entrepreneurship	0.711	0.917	0.733	0.787
Financial and Economic	Sustainable Profitability	0.728	0.933	0.750	0.804
	Cost Optimization	0.678	0.883	0.700	0.754
	Resource and Expenditure Management	0.761	0.933	0.800	0.831
	Microfinance	0.678	0.883	0.700	0.754
Management and Strategic	Strategic Planning	0.694	0.900	0.717	0.770
	Change Management	0.711	0.917	0.733	0.787
	Human Resource Development	0.656	0.883	0.667	0.735
	Organizational Innovation	0.650	0.867	0.667	0.728
	Corporate Governance	0.689	0.917	0.700	0.769
	Knowledge Management	0.644	0.883	0.650	0.726
	Organizational Culture	0.644	0.883	0.650	0.726
Legal and Regulatory	Banking Law Compliance	0.711	0.917	0.733	0.787
	Data Protection	0.706	0.900	0.733	0.780
	Anti-Money Laundering	0.711	0.917	0.733	0.787
	Financial Transparency	0.678	0.883	0.700	0.754
	Customer Rights	0.772	0.967	0.800	0.846
Banking Products and Services	Digital Banking	0.644	0.883	0.650	0.726
	Intelligent Advisory Services	0.761	0.933	0.800	0.831
	Customized Products	0.728	0.933	0.750	0.804
	Modern Payment Systems	0.772	0.967	0.800	0.846
	Social Loans	0.811	0.983	0.850	0.881
	Cooperative Services	0.678	0.883	0.700	0.754
Customer-Centricity and User Experience	Service Personalization	0.644	0.883	0.650	0.726
	Accessibility	0.811	0.983	0.850	0.881
	Intelligent Response	0.750	0.933	0.783	0.822
	Customer Satisfaction	0.694	0.900	0.717	0.770
Risk and Security	Cyber Risk Management	0.689	0.917	0.700	0.769
	Transaction Security	0.678	0.883	0.700	0.754
	Digital Identity Verification	0.570	0.604	0.638	0.604
	Fraud Monitoring	0.639	0.867	0.650	0.719
	Crisis Management	0.678	0.883	0.700	0.754
Sustainability and Sustainable Development	Environmental Responsibility	0.667	0. 883	0.683	0.744
	Sustainable Economic Development	0.750	0.933	0.783	0.822
	Social Justice	0.639	0.867	0.650	0.719
	Green Banking	0.570	0.604	0.638	0.604
	Energy Management	0.411	0.633	0.383	0.476

	Responsible Investment	0.711	0.917	0.733	0.787

Table 6. Components Suggested in First Delphi Round According to Expert Opinions

Dimensions	Components
AI Technology and Infrastructure	Localization of AI Technologies
	Banking Systems Integration
Social Development and Community Empowerment	Support for Domestic Production
	Local Economic Development
	Empowerment of Female-Headed Households
Financial and Economic	Liquidity Management in Inflationary Conditions
	Supply Chain Financing
Management and Strategic	Sanctions Management
	Development of Domestic Correspondent Network
Legal and Regulatory	Sharia Law Compliance
	Sanctions Risk Management
Banking Products and Services	Alternative SWIFT Banking Services
	Resistance Economy-Compatible Products

In the second round, 61 components (48 initial components plus 13 suggested components) were reassessed. The results of this round are presented in Table 7. After calculating the difference in expert opinions between the first and second rounds, it was determined that 15 components still lacked sufficient consensus.

Table 7. Results of Second Round of Fuzzy Delphi

Dimensions	Components	Expert Opinion Aggregation			Defuzzified Value	$\|S2-S1\|$
		l	*m*	*u*	*S2*	
AI Technology and Infrastructure	Machine Learning and Advanced Algorithms	0.711	0.917	0.733	0.787	0.094
	Natural Language Processing	0.728	0.933	0.750	0.804	0.018
	Expert and Decision Support Systems	0.711	0.917	0.733	0.787	0.000
	Cloud Computing	0.522	0.767	0.517	0.602	0.213
	Banking Internet of Things	0.383	0.417	0.367	0.389	0.067
	Big Data and Data Analytics	0.706	0.900	0.733	0.780	0.036
	AI Technologies Localization	0.811	0.983	0.850	0.881	0.881
	Banking Systems Integration	0.644	0.883	0.650	0.726	0.726
Social Development and Community Empowerment	Local Community Empowerment	0.644	0.883	0.650	0.726	0.004
	Small Business Support	0.700	0.917	0.717	0.778	0.050
	Social Project Participation	0.678	0.883	0.700	0.754	0.016
	Financial Inclusion	0.672	0.900	0.683	0.752	0.033
	Employment Creation and Entrepreneurship	0.694	0.900	0.717	0.770	0.017
	Support for Domestic Production	0.711	0.917	0.733	0.787	0.787
	Local Economic Development	0.694	0.900	0.717	0.770	0.770
	Empowerment of Female-Headed Households	0.811	0.983	0.850	0.881	0.881
Financial and Economic	Sustainable Profitability	0.750	0.933	0.783	0.822	0.018
	Cost Optimization	0.711	0.917	0.733	0.787	0.033
	Resource and Expenditure Management	0.694	0.900	0.717	0.770	0.061
	Microfinance	0.650	0.850	0.667	0.722	0.032
	Liquidity Management in Inflationary Conditions	0.644	0.883	0.650	0.726	0.726
	Supply Chain Financing	0.772	0.967	0.800	0.846	0.846
Management and Strategic	Strategic Planning	0.656	0.883	0.667	0.735	0.035
	Change Management	0.678	0.883	0.700	0.754	0.033
	Human Resource Development	0.650	0.867	0.667	0.728	0.007
	Organizational Innovation	0.689	0.917	0.700	0.769	0.041
	Corporate Governance	0.761	0.933	0.800	0.831	0.062
	Knowledge Management	0.678	0.883	0.700	0.754	0.028
	Organizational Culture	0.650	0.867	0.667	0.728	0.002
	Sanctions Management	0.761	0.933	0.800	0.831	0.831

	Development of Domestic Correspondent Network	0.678	0.883	0.700	0.754	0.754
Legal and Regulatory	Banking Law Compliance	0.689	0.917	0.700	0.769	0.018
	Data Protection	0.678	0.883	0.700	0.754	0.026
	Anti-Money Laundering	0.678	0.883	0.700	0.754	0.033
	Financial Transparency	0.761	0.933	0.800	0.831	0.077
	Customer Rights	0.672	0.900	0.683	0.752	0.094
	Sharia Law Compliance	0.644	0.883	0.650	0.726	0.726
	Sanctions Risk Management	0.639	0.867	0.650	0.719	0.719
Banking Products and Services	Digital Banking	0.667	0.883	0.683	0.744	0.018
	Intelligent Advisory Services	0.689	0.917	0.700	0.769	0.062
	Customized Products	0.678	0.883	0.700	0.754	0.050
	Modern Payment Systems	0.761	0.933	0.800	0.831	0.015
	Social Loans	0.639	0.867	0.650	0.719	0.162
	Cooperative Services	0.750	0.933	0.783	0.822	0.068
	Alternative SWIFT Banking Services	0.711	0.917	0.733	0.787	0.787
	Resistance Economy-Compatible Products	0.667	0.883	0.683	0.744	0.744
Customer-Centricity and User Experience	Service Personalization	0.811	0.983	0.850	0.881	0.155
	Accessibility	0.689	0.917	0.700	0.769	0.112
	Intelligent Response	0.678	0.883	0.700	0.754	0.068
	Customer Satisfaction	0.711	0.917	0.733	0.787	0.017
Risk and Security	Cyber Risk Management	0.678	0.883	0.700	0.754	0.015
	Transaction Security	0.772	0.967	0.800	0.846	0.092
	Digital Identity Verification	0.411	0.633	0.383	0.476	0.128
	Fraud Monitoring	0.694	0.900	0.717	0.770	0.051
	Crisis Management	0.850	0.881	0.912	0.881	0.127
Sustainability and Sustainable Development	Environmental Responsibility	0.694	0.900	0.717	0.770	0.026
	Sustainable Economic Development	0.689	0.917	0.700	0.769	0.053
	Social Justice	0.811	0.983	0.850	0.881	0.162
	Green Banking	0.383	0.417	0.367	0.389	0.215
	Energy Management	0.383	0.617	0.367	0.456	0.020
	Responsible Investment	0.711	0.917	0.733	0.787	0.000

In the third round, the remaining 15 components were re-evaluated, with results presented in Table 8. Calculation of expert disagreement between the second and third rounds showed that for all components, the difference had been reduced to below the 0.2 threshold level.

Table 8. Results of Third Round of Fuzzy Delphi

Dimensions	**Components**	**Expert Opinion Aggregation**			**Defuzzified Value**	**|S3-S2|**
		l	***m***	***u***	***S3***	
AI Technology and Infrastructure	Cloud Computing	0.570	0.604	0.638	0.604	0.002
	AI Technologies Localization	0.678	0.883	0.700	0.754	0.127
	Banking Systems Integration	0.761	0.933	0.800	0.831	0.105
Social Development and Community Empowerment	Support for Domestic Production	0.644	0.883	0.650	0.726	0.061
	Local Economic Development	0.689	0.917	0.700	0.769	0.001
	Empowerment of Female-Headed Households	0.689	0.917	0.700	0.769	0.112
Financial and Economic	Liquidity Management in Inflationary Conditions	0.678	0.883	0.700	0.754	0.028
	Supply Chain Financing	0.850	0.881	0.912	0.881	0.035
Management and Strategic	Sanctions Management	0.711	0.917	0.733	0.787	0.044
	Development of Domestic Correspondent Network	0.811	0.983	0.850	0.881	0.127
Legal and Regulatory	Sharia Law Compliance	0.811	0.983	0.850	0.881	0.155
	Sanctions Risk Management	0.678	0.883	0.700	0.754	0.035
Banking Products and Services	Alternative SWIFT Banking Services	0.750	0.933	0.783	0.822	0.035
	Resistance Economy-Compatible Products	0.678	0.883	0.700	0.754	0.010
Sustainability and Sustainable Development	Green Banking	0.383	0.617	0.367	0.456	0.067

After the third round, considering the threshold of 0.7 for final acceptance of components, 5 components

with defuzzified values below this threshold were eliminated (Table 9).

Figure 2. Comparison of Defuzzified Values Across Three Rounds of Fuzzy Delphi for Components

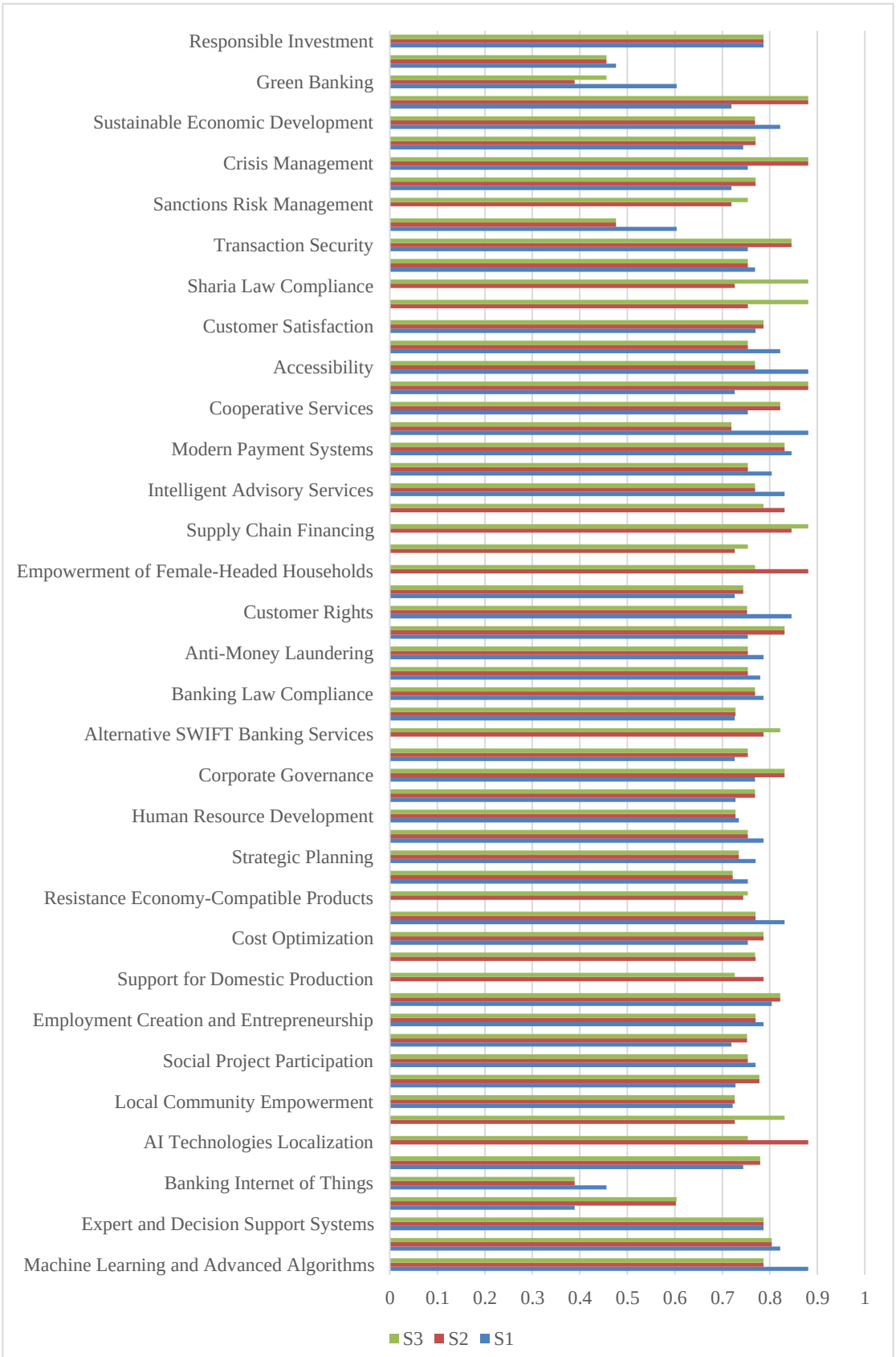

Table 9. Components Eliminated in Final Delphi Round According to Expert Opinions

	Components
1	Cloud Computing
2	Banking Internet of Things
3	Digital Identity Verification
4	Green Banking
5	Energy Management

To provide a visual representation of the fuzzy Delphi process and demonstrate the convergence of expert opinions across rounds, we present a comparative bar chart in Figure 2. This chart illustrates the defuzzified values of components across all three Delphi rounds, showing how expert consensus evolved throughout the process.

As shown in Figure 2

Figure 2, components with initially divergent expert opinions (e.g., "AI Technologies Localization" and "Empowerment of Female-Headed Households") demonstrated significant convergence by the third round, with reduced variation in defuzzified values. This visual comparison highlights the effectiveness of the fuzzy Delphi method in achieving expert consensus while capturing the inherent uncertainty in their judgments. Components that maintained consistently high defuzzified values across all rounds (e.g., "Supply Chain Financing" and "Alternative SWIFT Banking Services") represent areas of strong expert agreement regarding their critical importance for AI-based social banking implementation in Iranian cooperative banks. The final model, including 9 dimensions and 56 components, is presented in Table 10.

Table 10. AI-Based Social Banking Model for Iranian Cooperative Banks Using Fuzzy Delphi Approach

Dimensions		Components
AI Technology and Infrastructure	1	Machine Learning and Advanced Algorithms
	2	Natural Language Processing
	3	Expert and Decision Support Systems
	4	Big Data and Data Analytics
	5	AI Technologies Localization
	6	Banking Systems Integration
Social Development and Community Empowerment	7	Local Community Empowerment
	8	Small Business Support
	9	Social Project Participation
	10	Financial Inclusion
	11	Employment Creation and Entrepreneurship
	12	Support for Domestic Production
	13	Local Economic Development
	14	Empowerment of Female-Headed Households
Financial and Economic	15	Sustainable Profitability
	16	Cost Optimization
	17	Resource and Expenditure Management
	18	Microfinance
	19	Liquidity Management in Inflationary Conditions
	20	Supply Chain Financing
Management and Strategic	21	Strategic Planning
	22	Change Management
	23	Human Resource Development
	24	Organizational Innovation
	25	Corporate Governance
	26	Knowledge Management
	27	Organizational Culture

	28	Sanctions Management
	29	Development of Domestic Correspondent Network
Legal and Regulatory	30	Banking Law Compliance
	31	Data Protection
	32	Anti-Money Laundering
	33	Financial Transparency
	34	Customer Rights
	35	Sharia Law Compliance
	36	Sanctions Risk Management
Banking Products and Services	37	Digital Banking
	38	Intelligent Advisory Services
	39	Customized Products
	40	Modern Payment Systems
	41	Social Loans
	42	Cooperative Services
	43	Alternative SWIFT Banking Services
	44	Resistance Economy-Compatible Products
Customer-Centricity and User Experience	45	Service Personalization
	46	Accessibility
	47	Intelligent Response
	48	Customer Satisfaction
Risk and Security	49	Cyber Risk Management
	50	Transaction Security
	51	Fraud Monitoring
	52	Crisis Management
Sustainability and Sustainable Development	53	Environmental Responsibility
	54	Sustainable Economic Development
	55	Social Justice
	56	Responsible Investment

5. Discussion and Conclusion

The emergence of emerging technologies, particularly AI, along with increased social expectations from the banking system, has doubled the necessity of reviewing traditional banking business models. Cooperative banks, due to their socially-oriented nature, are uniquely positioned to pioneer this transformation. This research aimed to present a comprehensive model for implementing AI-based social banking in Iranian cooperative banks that could strengthen these banks' social role while leveraging the advantages of emerging technologies.

To achieve this objective, the research was conducted using a qualitative approach in two phases. In the first phase, using meta-synthesis method and systematic review of 36 scholarly articles published between 2014-2024, the initial dimensions and components of the model were identified. In the second phase, the extracted model was validated and localized through three rounds of fuzzy Delphi with the participation of 15 banking industry experts. The process resulted in the identification of 9 main dimensions and 56 components, which we will analyze in detail.

To provide a more comprehensive perspective on our research contribution, we compare our methodological approach and findings with other relevant methods in the field. When examining our fuzzy Delphi approach against the traditional Delphi method employed by Rezaei [31] and Mahmoodi et al. [21], several advantages emerge. While traditional Delphi offers simple implementation and direct consensus measurement, it cannot adequately capture uncertainty in expert opinions and relies on binary acceptance/rejection criteria. In contrast, our fuzzy Delphi approach provides superior handling of expert uncertainty through triangular fuzzy numbers and offers more nuanced component evaluation through defuzzified values, allowing for finer discrimination between components of varying importance.

Compared to AHP/ANP-based models used by Karimi & Mohammadi [17], which provide hierarchical prioritization and consider interdependencies, our method significantly reduces expert fatigue associated with numerous pairwise comparisons. While AHP/ANP offers detailed prioritization, our approach demonstrates greater practicality for evaluating large component sets (56 components in our study versus typically fewer than

20 in AHP studies), making it more suitable for comprehensive model development.

When contrasted with SWOT analysis employed by Yadegari Taheri et al. [42], which offers strategic orientation and simple categorization but suffers from limited quantification and lacks validation mechanisms, our model provides empirical validation through multiple Delphi rounds. This iterative validation process offers greater reliability than SWOT's qualitative assessments and leads to more robust conclusions.

Pure meta-synthesis approaches, such as those used by Shahbazi et al. [36], offer comprehensive literature integration and theoretical depth but typically lack empirical validation and remain context-independent. Our hybrid approach combines meta-synthesis's theoretical foundation with expert validation, creating a more robust and contextually relevant model that bridges theory and practice effectively.

Finally, in comparison to Structural Equation Modeling employed by Thongsri & Tripak [39], which offers statistical rigor and tests causal relationships but requires large sample data and has limited exploratory capacity, our approach better suits exploratory model development with limited experts. SEM is more appropriate for testing established models, whereas our method excels in developing new contextual frameworks.

This methodological comparison demonstrates the unique contribution of our approach. The combination of meta-synthesis with fuzzy Delphi offers advantages over single-method approaches: it balances theoretical comprehensiveness with practical validation, handles uncertainty more effectively than traditional consensus methods, reduces expert fatigue compared to AHP/ANP, provides empirical validation lacking in SWOT analysis, and offers exploratory flexibility not available in SEM.

Furthermore, our model differs substantively from previous models in its content and structure. While Mahmoodi et al. [21] focused on six dimensions primarily oriented toward digital transformation, our model expands to nine dimensions with particular emphasis on Iran-specific components. Similarly, Rezaei's [31] social banking model with a post-COVID approach did not address the AI integration aspects that our model comprehensively covers. Our localized components such as "Sanctions Management" (defuzzified value: 0.787), "Alternative SWIFT Banking Services" (0.822), and "Empowerment of Female-Headed Households" (0.769) represent unique contributions not found in existing models.

The "AI Technology and Infrastructure" dimension, with six key components, forms the technical foundation of the model. Findings show that machine learning, natural language processing, and expert systems are the most important AI functions in social banking. Notably, experts emphasized the importance of AI technology localization and banking systems integration, aspects that have received less attention in previous studies. This finding aligns with Radhakrishna et al. [27]'s research highlighting the vital role of integrated systems in the success of AI projects.

The "Social Development and Community Empowerment" dimension, with eight components, forms the heart of the social banking model. Special attention to empowering female-headed households, local economic development, and support for domestic production demonstrates the model's orientation toward local needs and Iranian society's requirements. These findings align with Hermawan & Rahayu [12]'s research emphasizing cooperative banks' role in local economic development.

In the "Financial and Economic" dimension, the six identified components indicate that cooperative banks must maintain a balance between sustainable profitability and microfinance. Special attention to liquidity management in inflationary conditions and supply chain financing demonstrates the model's deep understanding of the country's economic challenges. These findings align with Venanzi & Matteucci [41]'s study on cooperative banks' financial sustainability.

The "Management and Strategic" dimension, with nine components, covers a range of issues from strategic planning to sanctions management. Experts' emphasis on developing domestic correspondent networks and sanctions management demonstrates the model's realistic approach to existing constraints. These findings show greater attention to specific challenges in Iran's business environment compared to previous studies.

The "Legal and Regulatory" dimension, with seven components, defines the model's regulatory framework. Beyond conventional components like banking law compliance and anti-money laundering, special attention to Sharia law compliance and sanctions risk management demonstrates the model's sensitivity to specific

requirements of Iran's banking system. These findings align with Iannaci & Gideon [14]'s research on the importance of Sharia compliance in social banking.

In the "Banking Products and Services" dimension, the eight identified components show that services should be an intelligent combination of technological innovation and response to social needs. The particular importance of alternative SWIFT banking services and resistance economy-compatible products reflects the model's deep understanding of Iran's specific economic needs. This approach aligns with Patel & Patel [25]'s findings regarding the necessity of adapting banking services to local conditions.

The "Customer-Centricity and User Experience" dimension, with four components, emphasizes service personalization and accessibility. Notably, the simultaneous emphasis on intelligent response and customer satisfaction shows that technology should serve to improve the human experience. This finding aligns with Jakšič & Marinč [15]'s research on the importance of maintaining balance between technological innovation and human relationships.

The "Risk and Security" dimension, with four components, addresses security challenges in the digital age. Focus on cyber risk management and transaction security shows that the success of intelligent social banking requires creating a secure and reliable platform. These findings align with Sadok et al. [32]'s results regarding the importance of security in adopting new banking technologies.

The "Sustainability and Sustainable Development" dimension, with four components, outlines the model's long-term vision. Simultaneous emphasis on environmental responsibility, sustainable economic development, and social justice shows that intelligent social banking must achieve a dynamic balance between economic, social, and environmental objectives. This approach aligns with de Andreis et al. [7]'s findings regarding AI's role in achieving sustainable development goals.

Managerial Implications

The findings of this research offer several significant managerial implications for different stakeholders in the banking ecosystem, particularly for cooperative banks seeking to implement AI-based social banking models:

For Cooperative Bank Executives and Board Members:

- Strategic Prioritization: Our fuzzy Delphi results provide evidence-based guidance for resource allocation. The components with highest defuzzified values (e.g., AI technologies localization: 0.754, supply chain financing: 0.881, alternative SWIFT banking services: 0.822) should receive priority in implementation planning and budgeting.

- Phased Implementation Approach: The nine dimensions identified in our model can serve as a roadmap for phased implementation, starting with foundational dimensions (infrastructure, legal framework) before progressing to advanced dimensions (personalization, sustainability).

- Talent Development Strategy: The identification of specific AI capabilities requires targeted talent acquisition and development. Executives should develop specialized training programs focusing on the six AI technology components identified in our model.

- Localization Focus: The high prioritization of context-specific components suggests executives should invest in developing localized solutions rather than directly adopting international models that may not address Iran's specific challenges.

For Banking Technology Officers:

- Technology Selection Criteria: When evaluating AI solutions, technology officers should prioritize systems that can be effectively localized and integrated with existing banking infrastructure, as indicated by the high importance of these components.

- Development Roadmap: Our model provides a clear framework for developing a technology roadmap that balances social impact and technical feasibility.

- Security-First Approach: The high defuzzified values for cyber risk management (0.754) and transaction security (0.846) indicate that security considerations should be integrated from the beginning of any technology implementation, not added as an afterthought.

- Integration Requirements: The high prioritization of banking systems integration (0.831) indicates that technology officers should focus on interoperability and avoid creating isolated technological solutions.

For Policymakers and Regulators:

- Regulatory Framework Development: Our model identifies key regulatory components that should be addressed in developing new banking regulations, particularly regarding AI ethics, data protection, and sanctions compliance.

- Support Mechanisms: The identification of specific implementation challenges provides guidance for developing targeted support programs, such as innovation funds or regulatory sandboxes for cooperative banks.

- Performance Metrics: Regulators can use our dimensional framework to develop comprehensive performance evaluation metrics that extend beyond traditional financial indicators to include social impact and technological advancement.

These managerial implications provide actionable guidance for implementing AI-based social banking in cooperative banks, transforming our theoretical model into practical strategies that can drive digital transformation while enhancing social impact.

Beyond the theoretical implications discussed above, our research has direct practical applications. Building upon the managerial implications, we offer specific recommendations for key stakeholder groups to facilitate implementation:

For cooperative bank managers, the implementation process should begin with a strategic assessment of current capabilities against our nine-dimensional model, identifying priority gaps for immediate action. Operationally, banks should establish dedicated innovation teams responsible for driving the AI-social banking integration, with clear performance metrics aligned with both technical and social dimensions.

For policymakers and regulatory bodies, developing a principle-based rather than rule-based regulatory approach would provide the necessary flexibility for innovation while maintaining system stability. Creating specialized regulatory sandboxes for cooperative banks to test AI-based social banking solutions in controlled environments could accelerate adoption while managing risks effectively.

For technology companies and AI solution providers, adopting co-creation approaches with cooperative banks would ensure solutions address the specific constraints identified in our research. Developing modular and scalable platforms that allow for progressive implementation based on each bank's readiness level would increase adoption success rates.

These targeted recommendations complement the broader managerial implications by providing actionable next steps for each stakeholder group.

Limitations and Future Research

This research faced several limitations. First, limited access to international scientific resources due to sanctions may have excluded some relevant studies from the meta-synthesis process. Second, focusing on domestic experts in the Delphi process may have limited international perspectives. Third, the qualitative nature of the research limits result generalizability. Fourth, inability to pilot test the model in a cooperative bank to assess its applicability.

Given these limitations, several suggestions are made for future research. Quantitative studies to test and validate the model in a larger sample of cooperative banks are recommended. Additionally, in-depth case studies to examine model implementation challenges in practice would be useful. Developing quantitative indicators for measuring intelligent social banking success, and comparative study of cooperative banks' experiences in different countries could enrich the literature in this field. Finally, future research could focus on designing regulatory frameworks suitable for intelligent social banking and developing AI-based algorithms for social impact assessment.

Conflict of interest: The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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