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Application of Fuzzy DANP for Implementation of FinTechs in Financial-Banking System

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ABSTRACT

Despite the growth of financial technologies (FinTechs) and their impact on transforming financial services, the implementation of fintech for gaining a competitive advantage in banks appears essential. The aim of this article is to model and determine the relationships and relative importance of the dimensions and components of implementing fintech in the financial-banking system. To this end, the research was conducted with a qualitative and quantitative approach in 2023. The research community included 12 experts, comprising managers and senior specialists from state banks, who were selected purposefully and theoretically. The data collection tools were semi-structured interviews for the qualitative section and a pairwise comparison questionnaire for the quantitative section. The results of the qualitative section, analysed through content analysis, indicated that the model includes dimensions such as "infrastructure and technical", "organizational policies", "products and services", "market", "marketing and sales", "economic", "human resources" and "ecosystem." The quantitative results, analysed using fuzzy DEMATEL, showed that "products and services" is the most influential and critical dimension in the model, suggesting that the success of implementing the model depends on improving this dimension. "Ecosystem" is the most impactful dimension with the strongest relationship in implementing the model, leading to the model's improvement. The findings of the network analysis process also indicated that the components of "product and service diversity", "security and privacy protection", "product and service adaptability" and "creating a platform and sharing it" are the most important. Based on the results, it is recommended that banks invest in those financial technologies (fintech) that can quickly respond to the desires and needs of their customers for successful fintech implementation.

1 Introduction

Due to the growth of smart technologies in recent years, banks and financial institutions have been utilizing modern digital technologies to optimize banking operations [1]. One of these technologies is

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fintech. Fintech's are technological innovations in financial services that offer financial products with features similar to banking products [2]. The use of fintech applications can significantly reduce the high operational costs of financial services [3]. Research shows that implementing fintech solutions can greatly enhance operational performance in the banking industry, such as reducing non-performing loans and improving asset quality [4, 5]. Furthermore, implementing fintech can improve the quality of services provided by banks and financial institutions by facilitating the delivery and flexibility of banking services [6], which ultimately leads to gaining competitive advantage, profitability, increased customer satisfaction, and reduced costs [7]. Given the advantages that fintech has provided for the growth of banks and the economy in recent years, competition for leveraging innovative and cutting-edge technologies in the financial sector has also increased [8]. For this reason, fintech continues to grow globally. According to reports, as of January 2024, there were approximately 13,100 fintech companies in the Americas, 10,969 in Europe, the Middle East, and Africa, and 5,886 in Asia and Oceania. It is projected that by 2024, the total revenue of the global fintech sector will reach $188 billion [9]. On the other hand, the growth of fintech in Islamic communities is significantly increasing, with the transaction value of Islamic fintech being 6% higher than that of non-Islamic fintech [4]. Particularly, the adoption of fintech has been growing globally since the COVID-19 pandemic, leading to a necessity for fintech adoption to meet customer needs, achieve competitiveness, and enhance the performance of the banking industry [8].The adoption of fintech by banks and financial institutions is important for several reasons, including the provision of effective and efficient financial services through simplified processes [8], resource efficiency, sustainable and secure supply of financial resources in banking operations [1], and the growing threat posed by FinTech in capturing the financial services market [10]. However, there are numerous challenges from technical and managerial perspectives [11], such as high information technology system costs and strict regulations [12], lack of mutual cooperation between FinTech and banks to carry out processes [13], and significant disruptions in financial services [14]; Ignoring these challenges can lead to project failure.Despite the threat of fintech project failures, financial industry leaders, such as banks, must invest in research and development activities to adopt FinTech to become less vulnerable [15]. Investing in fintech implementation depends on various internal and external factors [16]. By focusing on these factors, banks can effectively fulfill their duties to shareholders [17] and minimize project failure [18]. Therefore, the success or failure of fintech implementation by banks is dependent on planning and key factors that can have significant impacts on the well-being of customers and service providers [19].Studies on the adoption of fintech in the theoretical literature, both domestically and internationally, are on the rise. Domestic studies have focused on the role of customers in adopting financial technologies [20], the factors influencing financial technology in the banking industry [21], and the improvement of strategic relationships and cooperation between the banking system and FinTech [22]. However, researchers have not yet reached a consensus on which areas and factors can effectively contribute to the implementation of FinTech in the country's financial systems, and there remains a research gap in addressing this question. Given the growing attention of banks to fintech and the increasing interest in its implementation, coupled with the significant costs associated with potential failures in fintech implementation by banks, it seems necessary to conduct the present study with the aim of identifying and analyzing the dimensions and components of fintech implementation in the country's banking systems to reduce this research gap. On the other hand, the adoption of FinTech enables banks to maintain their competitive edge. However, fintech implementation in banks still faces challenges because fintech, as a new entity and service, is not necessarily well-adopted and utilized by

banks. Banks need to understand various factors affecting its use and achieve consensus on these factors.Therefore, it is essential to have a deeper understanding of what makes fintech implementation successful and how to create a model for implementing FinTech in the banking system. Especially considering that fintech adoption is still at a preliminary stage in Iranian banking services and it appears that there is a need for further development in financial infrastructures. Despite the measures taken by banks in this direction and efforts to adopt and successfully implement fintech, the effective components of successful fintech implementation are not yet clearly defined. Therefore, this research aims to identify and model the implementation of FinTech in the financial-banking system through a composite of Analytic Network Process based on DEMATEL phase methodology. Consequently, the research questions are as follows:

1. What dimensions and factors are influential in the implementation of FinTech within the financial-banking system?
2. How do the relationships and impacts of these dimensions and factors affect the implementation of FinTech in the financial-banking system?
3. What is the relative importance of the dimensions and factors affecting the implementation of FinTech in the financial-banking system?

This study has been conducted in five sections. In the continuation of this research, a review of the theoretical and empirical literature is provided. The third section explains the research methodology and the methods used. The fourth section presents the research findings, and finally, the last section provides conclusions and recommendations based on the research results.

2 Backgrounds and Literature

The term "Fintech" is a combination of the words "financial" and "technology," used to denote technologies applicable to the provision of financial products [23]. Some researchers define fintech as a financial service or industry that combines financial services or businesses with information technology [24]. The fintech ecosystem includes startups, technology developers, governments, financial customers, and mutual financial institutions [25]. Pham et al [26], describe the concept of fintech as primarily referring to financial technologies utilized by traditional financial institutions under the name "fintech bank." Additionally, organizations that indirectly use technologies to provide financial products or services are also considered part of the fintech external realm. The fintech sector offers various business models for each product or service, including payments, wealth management, aggregate financing, lending, capital markets, and insurance services [27], and making decisions about their management are very important that can improve the performance of banks [28]. Some of the fintech services in the banking industry include: electronic money, online money transfers, electronic account management, digital currencies, electronic housing loans, electronic wire transfers, electronic financing, electronic leasing, cash management, digital education, digital factoring, and online insurance [8]. Additionally, FinTech possess potential and additional prospects through the integration of new technologies such as artificial intelligence, blockchain, digital currencies, and metaverse, which assist in digital payments, telebanking, money transfer services, and digital currency transactions [29].Romānova and Kudinska [30], defined two types of fintech companies. The first type consists of companies that provide auxiliary banking services. These companies (such as fintech startups and scale-ups) could potentially be key partners for banks. The second type includes companies that offer financial services that customers can find within banks. Li and Shin [31] categorized various players in the fintech ecosystem into fintech startups; technology developers (such as blockchain analysts); governments; financial customers (both

retail and corporate); and traditional financial institutions (such as banks and insurance companies). Researchers have identified key impacts created by digital banks through fintech as follows: (1) impacts on the entire industry, (2) impacts on business models, (3) impacts on society, especially from the family perspective, (4) impacts on customers and their relationships with banks, (5) impacts on the lending processes for small and medium enterprises, and (6) impacts on the level of innovation in financial services [32].In foreign studies, Nalluri and Chen [33] concluded in their study on the barriers to FinTech adoption that weak government regulations, combined with safety and reliability issues, are the main challenging obstacles that stakeholders and policymakers involved in the development of financial infrastructure need to pay more attention to. Kajla et al [34], using the Fuzzy Analytical Hierarchy Process (Fuzzy-AHP) method, showed that the organizational dimension is the most important criterion for the adoption of blockchain in the banking sector, followed by the environmental dimension. In contrast, the technological dimension has the least impact. Customer pressure, IT resources, financial resources, competitor pressure, and relative advantage are the most influential sub-criteria for blockchain adoption. Bouteraa et al [35], in their study on the behavior and perception of bank customers regarding the benefits of FinTech services, emphasized the organizational, technological, individual, and environmental aspects of FinTechs. To maintain consistency in quality, FinTech providers should focus on delivering useful, accessible, fast, convenient, functional, and flexible services in addition to concentrating on security precautions and privacy protection. Lestari and Rahmanto [36] identified investment in software, hardware, and even in financial technology companies as the most important challenges for implementing Fintechs. In the study by Mathur et al [6], challenges such as customers' perceived value, big data management, banking regulations, and money laundering risks were identified as the most influential challenges facing financial institutions in adopting financial technologies using the DEMATEL method. Makki and Alqahtani [37] modelled the enablers for Fintech innovation using Interpretive Structural Modelling (ISM) and Analytical Network Process (ANP) techniques. The findings of this study showed that financial ethics and literacy, personal data protection, customer protection, security, and infrastructure are dependent enablers, while independent enablers include regulations and policies, regulators, payment systems, technology, frameworks and models, and digital insurance. Kukreja et al [38] attributed Fintech development to government-driven digitization initiatives, improved literacy levels, and encouragement of changes in financial policies regarding corporate taxation and strengthening policies in financial services. Pham et al [26] introduced the most critical components of bank FinTechin the internal domain, including Fintech company pressure, bank Fintech strategy, and human resource quality, and in the external domain, including disruptive technology, Fintech regulations, and the business environment. Hoang et al [39] emphasized that collaboration between banks and FinTechleads to increased brand recognition, strengthened customer trust, and easy access to capital. Similarly, Horváth et al [15] showed that collaborating with Fintech startups is a cost-effective method for banks to offer innovation, and thus they can also avoid potential future competition. However, problems with banking IT systems, undefined development needs, and challenges related to human resources are some of the issues faced by banks, while FinTech encounter challenges such as attitudinal problems, human resource challenges like weak sales abilities, and incomplete knowledge of regulations in their interactions and collaborations. Mishra et al [1] identified the ease of local and international regulations and the preservation of user data privacy as the most critical success factors for the adoption of blockchain technology for banking operations.Zalan-Toufaily [40] identified the potential strategic options for banks in response to the emergence of FinTech companies, including maintaining the status quo, expanding their digital capabilities, launching their own Fintech organization, investing

in Fintech companies, and developing partnerships and collaborations with Fintechs. They suggested that developing various forms of collaboration will likely dominate in the future.Domestic empirical studies also indicate that government factors such as laws, managerial and structural factors, culture and technological advances in financial fields and modern banking services are effective in the implementation of fintech in Iran's banking industry [41]. Also, the factors influencing financial technology in the banking industry include internal factors such as bank audits, external and environmental factors such as the business environment, intervening factors such as industry growth opportunities, and financial factors such as revenues and expenses, which are the most influential in the development of financial technology in the banking industry and FinTech [21]. In the study by khazaei et al [20], they analyzed how customers adopt FinTechs, and their findings showed that customers' perceptual characteristics such as perceived security, awareness, efficiency, ease of use, and relative advantages affect their attitudes toward . Adopting FinTechs. Therefore, banks need to focus on customer features and needs when implementing FinTech to ensure customer acceptance. Tahmasebi Aghbolaghi et al [22], in their study on strategic collaboration between the private banking system and FinTechin Iran, identified environmental decision-making factors influencing the business environment of startups, collaboration strategies, customer awareness and behaviours, the structure and management of the banking industry, investment, and Fintech development as important in shaping and developing strategic collaboration for growth and financial, process, operational, and communication outcomes.As the domestic empirical evidence suggests, the factors and components influencing the implementation of FinTech have not been clearly identified based on empirical findings, and researchers have not reached a consensus on this matter. However, identifying and analysing these factors is crucial, given the increasing competition in the financial and banking services sector with the entry of Fintechs. The innovation of the present study lies in addressing this issue. Several researchers have examined the relationship between ownership structure and stock liquidity of companies listed on the Tehran Stock Exchange. The effects of ownership structure were analyzed in two dimensions: ownership type and ownership concentration. The findings of their study indicated an inverse relationship between the level of institutional ownership, managerial ownership, and ownership concentration with liquidity. Moreover, a direct relationship was identified between the level of corporate ownership and liquidity [48].

3 Research Method

Since this research aims to develop applied knowledge in the field of Fintech implementation in the financial-banking sector, the present study is applied and developmental in its objectives. The data for this research has been analysed using a mixed qualitative and quantitative approach. In the qualitative section, content analysis was used to identify the model indicators through semi-structured interviews. The interviews lasted approximately one hour on average, with the first fifteen minutes dedicated to explaining the study's objectives and the key indicators influencing Fintech implementation. Then, keywords were collected, and responses were recorded in the required format. In this section, the indicators were converted into components and dimensions using the coding technique, and the elements of the model were identified. The research population consisted of experts, senior managers, and specialists from state-owned banks in Tehran, totalling 12 people who were selected based on characteristics such as full awareness of the research topic, sufficient motivation, and willingness to collaborate with the researcher. The criterion for selecting the experts was theoretical saturation, and they were chosen through purposive and theoretical non-probability sampling. The content validity and reliability of the

indicators were examined using the fuzzy Delphi method. The fuzzy Delphi method is an interactive approach based on surveys and feedback from decision-makers until a consensus on the research topic is reached. It is also used for the logical and systematic evaluation of experts, regardless of their perspectives and subjective biases. The Delphi method is essentially an interactive survey-based and feedback-driven approach [42]. In the quantitative section, for modelling through determining the relationships and the degree of influence and impact of the dimensions and components of the Fintech implementation model in the financial-banking sector, we used the fuzzy DEMATEL method. To determine their relative importance, we applied the fuzzy Analytic Network Process based on DEMATEL (F. DANP). DEMATEL is an appropriate method for complex structures as it examines the network of relationships between influential parameters and presents a visual structural model in the form of a cause-and-effect graph [43]. Therefore, in this research, due to the need to identify the relationship between the levels of indicators and determine their cause and effect in a classified diagram, we used fuaay DEMATEL. Then the weight and importance of dimensions and factors were obtained based on the analytical network process. The steps of this method are outlined in the mentioned source [44]. For applying DEMATEL, we used a pairwise comparison questionnaire, in which the experts rated the influence of each dimension of the model on the others as 'No Influence (0)', 'Low Influence (1)', 'Moderate Influence (2)', 'High Influence (3)', and 'Very High Influence (4)'. The proposed problem solving method is illustrated in Figure 1.

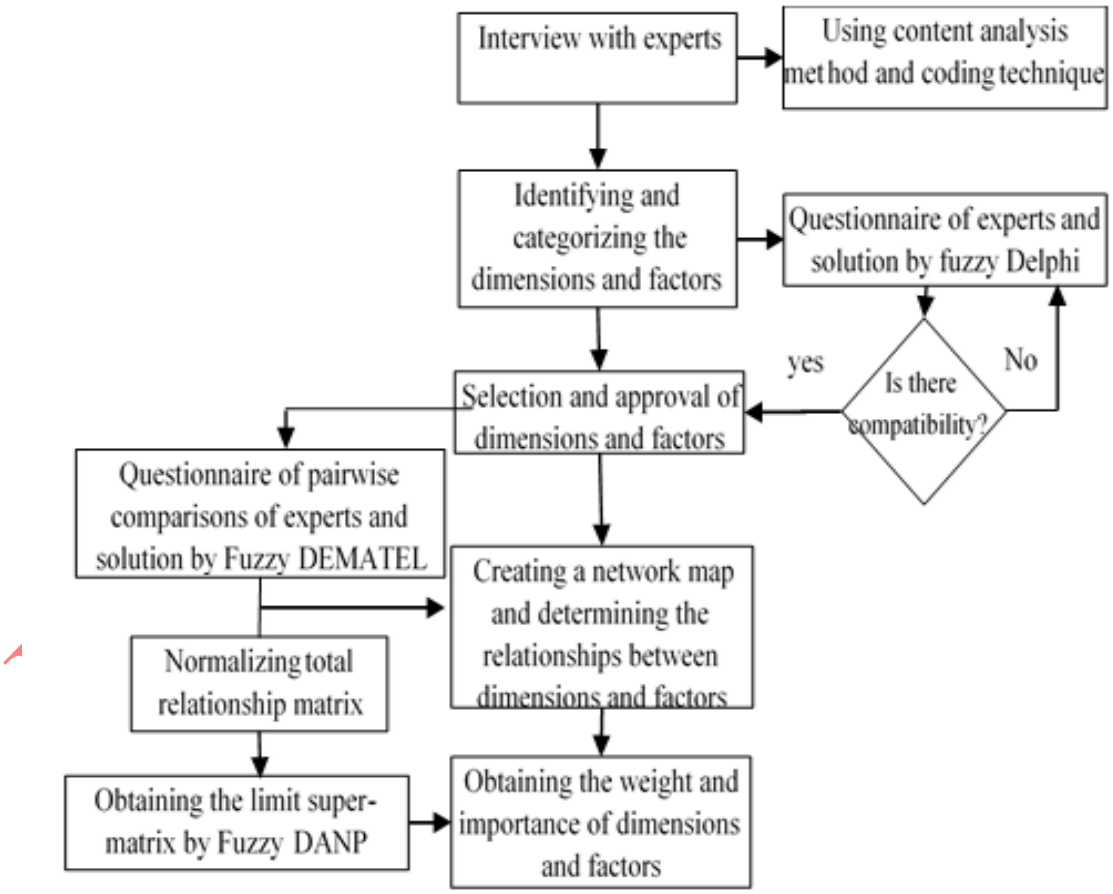

Fig. 1: Procedures of the fuzzy DANP model to evaluation of Implementation of FinTech in Financial-Banking System

4 Findings

The first part of the data analysis is qualitative. In this section, key terms identified from semi-structured interviews were converted into indicators through coding.

Table 1: Dimensions, Components, and Indicators of the Fintech Implementation Model in the Financial-Banking System

Dimensions	Factors	Metrics
Infrastructure and Technical	Suitable Platform and Development of Necessary Infrastructure	Availability and Readiness of Infrastructure: IT Infrastructure - Provision of Hardware and Technology - Platforms of Other Companies and Organizations
	Creating a Platform and Sharing It	Creating a Shared Platform
	Software Platform Services	Software Licenses
Organizational Policy Organizational Policy	Clear Vision and Forward Thinking	Policy Planning Development: Realistic and Valuable Vision - Clear Objectives - Development and Improvement Plans
	Strategic Alliance of FinTechwith Banks	Collaborative Partnership
	Management Support	Organizational Structure Setup - Team Building - Establishing Procedures and Guidelines - Supporting Initiative, Creativity, and Innovation
	Adaptability	Environmental Monitoring - Age Pyramid Changes
Products and Services	Product and Service Diversification	Offering New Services - Facilitating Financial Operations - Greater Accessibility - Creating and Innovating New Financial Services
	Product and Service Adaptability	Easy Compatibility of the Product with Other Technologies
	Security and Privacy Protection	Strong Security Measures - Awareness of Security Threats - Necessary Security Infrastructure - Risk of Information Disclosure by Human Resources
Market Factor	Market Demand	Market Competition - Relationships between Financial Services Companies and FinTech Companies
	Financial and Banking Services	Communication Platforms - Data Sharing - Shared Hub
	Technology Development	Global Communication Networks - Internet Broadband
Marketing and Sales	Service and Product Delivery Time	Access to Services Anytime and Anywhere - Quick Response
	Introduction and Sales	Advertising - More Effective Trust Building
	Desired Quality of Products and Services	Customer Satisfaction - Ethical Considerations - Customer Relationship Management
	Identifying Customer Needs and Responding to Them	Understanding Customer Preferences - Understanding Consumer Insights - Data Collection - Advanced Analytics for Better Consumer Understanding
Economic	Infrastructure Investment Planning	Availability of Financial Resources - Capital Budgeting - Operational Budgeting
	Financial Limitations	Exchange Rate Fluctuations - Inflation - Liquidity Shortages
	FinTech Setup and Development Costs	Joint Investment - High Security Costs - High Hardware Costs
	Costs of Specialized Personnel	Training Costs - Hiring Costs
Human Resources	Employee Retention Policy	Implementing a Merit-Based System - Providing Scientific and Research Facilities - Adequate Compensation and Payroll System
	Effective Management of Knowledge and Skills	Information Sharing System - Effective Communication Among Employees - Knowledge Management Evaluation System
	Human Resource Expertise	Initiative, Creativity, and Innovation - High Skill Level - Relevant Work Experience - Training and Development
Ecosystem	Legal Matters	Familiarity with Business Laws - Lack of Access to Big Data - Absence of Rule of Law
	Government Support	Taxes - Financial Assistance - Cooperation of Government Agencies
	Government Regulations	Anti-Money Laundering - Sector-Specific Regulations - Administrative Bureaucracy

Subsequently, indicators with similar meanings were grouped into higher categories through axial coding, forming components. In the third stage of selective coding, components that could generate a new theory were grouped into a larger category, forming the dimensions of the Fintech implementation model in banking-financial systems. The components and indicators were then screened using the fuzzy Delphi method, and consensus opinions from experts were obtained. For this purpose, a questionnaire was designed, and experts rated the importance of each component and indicator on a 9-point scale from 'Not Important at All' to 'Extremely Important.' The Delphi method was implemented in three rounds. Based on Modiri et al [45], components with expert disagreement below the threshold of 0.2 and with an average opinion score above 8 were selected. The results showed that the components 'Increased Internet Penetration,' 'Smart Devices,' 'Existence of Restrictive Sanctions,' 'Industry Growth,' and 'Role of Stakeholders' were removed from the model, and 27 components along with 8 dimensions were selected for the final model. These findings are presented in Table 1.

In the second part of the quantitative analysis, the goal of using the fuzzy DEMATEL approach is to analyse causal relationships and to create a comprehensible diagram of the network of interactions between the dimensions and components of the Fintech implementation model in financial-banking systems. A total of 8 dimensions and 27 components, identified through qualitative content analysis and validated using the fuzzy Delphi method, were considered for analysis using DEMATEL. These dimensions and components are comprehensively summarized and presented in Table 1. For the survey, a pairwise comparison questionnaire was designed, and the collected data from 12 experts were used as input for the DEMATEL modelling process. In the first stage of fuzzy DEMATEL, the experts definitive opinions were converted into fuzzy numbers based on very high impact (1, 1, 0.75), high impact (1, 0.75, 0.5), low impact (0.75, 0.5, 0.25), very low impact (0.5, 0.25, 0), and no impact (0.25, 0, 0) [48]. Then, the fuzzy direct matrix was formed based on the aggregation of experts' opinions using the arithmetic mean, as shown for the dimensions in Table 2. In Table 2, L represents the lower limit of the triangular fuzzy number, M represents the middle limit, and U represents the upper limit of the triangular fuzzy number, indicating the intensity of the impacts of the dimensions. The construction of the fuzzy direct matrix shows the evaluation of the relationships between the dimensions.

Table 2: Fuzzy Direct Matrix of Dimensions

	C1			C2			C...	C8			C9		
	L	M	U	L	M	U	...	L	M	U	L	M	U
C1	0	0	0	0.02	0.07	0.32	···	0.05	0.11	0.36	0	0.04	0.29
C2	0.09	0.14	0.39	0	0	0	...	0.07	0.13	0.38	0.02	0.05	0.3
C3	0.05	0.11	0.36	0.02	0.07	0.32	···	0.05	0.11	0.36	0	0.02	0.27
C4	0.14	0.2	0.41	0.07	0.13	0.38	...	0.14	0.2	0.41	0.02	0.07	0.32
C5	0.05	0.11	0.36	0.02	0.05	0.3	···	0.02	0.07	0.32	0.02	0.04	0.29
C6	0.11	0.16	0.41	0.02	0.07	0.32	...	0.09	0.14	0.39	0	0.02	0.27
C7	0.07	0.13	0.38	0	0.05	0.3	...	0	0	0	0	0.02	0.27
C8	0.14	0.2	0.41	0.09	0.14	0.39	...	0.13	0.18	0.39	0	0	0

In the second stage, the normalized matrix was obtained based on Relation 1, where the inverse of the largest column and row sums in the fuzzy direct matrix, equal to 0.348, was multiplied by the fuzzy direct matrix to obtain the normalized matrix.

$$k = min\left[\frac{1}{max_{1\le i\le n}\sum_{j=1}^{n}\tilde{A}_{ij}}, \frac{1}{max_{1\le i\le n}\sum_{i=1}^{n}\tilde{A}_{ij}}\right] \quad i,j = 1,2\ldots n \quad , \quad \tilde{X} = K.\tilde{A} \tag{1}$$

In the third stage of this method, the total impact matrix was created using the normalized direct impact matrix. At this stage, based on Relation 2, an identity matrix was subtracted from the normalized direct impact matrix, and after multiplying it by the inverse of the normalized direct impact matrix, the overall relationship matrix was obtained.

$$\tilde{T} = \tilde{X}(I - \tilde{X})^{-1} \tag{2}$$

In the fourth stage of this method, the row sums ($\tilde{R}_i$) and column sums ($\tilde{D}_i$) were obtained using the overall relationship matrix. Then, the vectors ($\tilde{D}_i + \tilde{R}_i$) were calculated to determine the interactions, and ($\tilde{D}_i - \tilde{R}_i$) were calculated to determine the net impact or influence and the nature of the relationships between the dimensions and components. According to the DEMATEL method, positive values of ($\tilde{D}_i - \tilde{R}_i$) indicate that the dimension is an influencing factor or cause, while negative values indicate that the dimension is an affected factor or effect. These values are presented in Table 3 for dimensions and Table 4 for components of the Fintech implementation model in financial-banking systems.

Table 3: Impact, Influence, Interaction, and Net Impact/Influence of Dimensions

Dimensions	Impact	Influence	Interaction	Impact/Influence	Result
Infrastructure and Technical	2.203	2.523	4.726	-0.32	Influenced
Organizational Policy	2.337	2.111	4.448	0.227	Influenced
Products and Services	2.14	2.769	4.909	-0.63	Most Influenced
Market Factors	2.596	1.962	4.558	0.634	Influential
Marketing and Sales	2.086	2.657	4.743	-0.57	Influenced
Economic	2.334	2.225	4.559	0.109	Influential
Human Resources	2.145	2.411	4.556	-0.27	Influenced
Ecosystem	2.599	1.781	4.38	0.817	Most Influential

The findings from Table 3 indicate that the dimensions of "Ecosystem", "Market Factors", "Organizational Policy", and "Economic" have positive $\tilde{R}$ - $\tilde{D}$ values, making them the most influential and having the greatest impact on other factors. Among these dimensions, "Ecosystem" is the most influential with the highest positive $\tilde{R}$ - $\tilde{D}$ value for guiding the system. This finding suggests that the successful implementation of fintech requires government support, and governmental regulations can facilitate the execution and accelerate the growth of fintech. On the other hand, improving the fintech ecosystem will enhance the market potential for gaining competitive advantages and create a potential opportunity for banks to achieve profits, which requires clear visions and managerial support. These data form the model for fintech implementation in the financial system, as illustrated in Figure 1.Therefore, among the primary factors, “environmental factors” with a net influencing/influenced rate of 0.921 are the most influencing factors, while “operational factors” with a net influencing/influenced rate of

1.07 are the most influenced factors. In general, positive $\tilde{R}$-$\tilde{D}$, causal factors, and negative $\tilde{R}$-$\tilde{D}$ are considered influenced passive factors. Thereafter, the Network Relationships Map (NRM) was plotted based on data in Table 3, as shown in Figure 2.

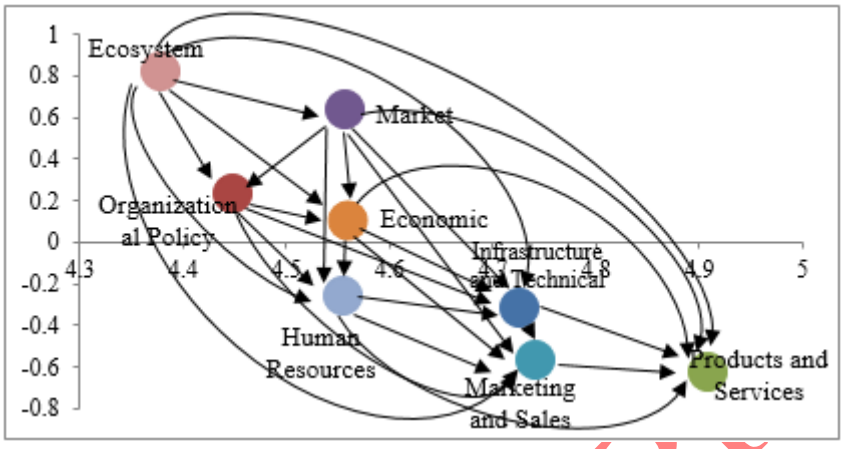

Fig. 2: Model of Fintech Implementation in the Financial-Banking Sector Based on Causal Relationship Network Map

As shown in Figure 1, the dimensions "Human Resources", "Infrastructure and Technical", "Marketing and Sales" and "Product and Services" have negative $\tilde{R}$ - $\tilde{D}$ values, indicating that they are influenced by other factors and are therefore considered to be dependent or "effected" by the dimensions with positive $\tilde{R}$-$\tilde{D}$ values. Specifically, "Product and Services" is identified as the most affected dimension, with the greatest negative $\tilde{R}$-$\tilde{D}$ value. This finding emphasizes that the initial success of Fintech implementation depends significantly on the "Product and Services" dimension. For financial institutions, improving this dimension is crucial to providing diverse and secure services to customers, preventing market lag, and staying competitive against Fintech rivals.However, to succeed in delivering effective products and services, attention must also be given to the influential dimensions. As depicted in Figure 1, the "Ecosystem" dimension, which includes legal and regulatory support from the government, plays a critical role. Government actions can facilitate the implementation process through supportive legislation. Additionally, banks must focus on financial technologies and related services to align and implement their policies effectively. Table 4 provides details on the impact and influence of various components within the Fintech implementation model. It shows the degree of impact and influence among components, detailing how each component affects and is affected by others.Table4 findings also indicate that among the components of the ecosystem, the factors "government support," "government regulations," and "legal issues" have the greatest impact, respectively. According to this, legal support and organized, motivating legal issues compel and encourage banks to implement fintechs, aiming for industrial development of the country through their growth. Among the components of the market dimension, "technology development", "market demand" and "financial and banking services" are respectively influential. This result arises because, with the development of financial technologies and the provision of new financial services, market demand is expected to grow, and consequently, financial and banking services will expand to offer these services. Overall, this leads to banks providing innovative services based on technology development to their customers.Among the components of the organizational policy dimension, "strategic alliance of FinTech with banks", "clear vision and forward-thinking", "adaptability" and "management support" are, respectively, influential in policymaking.

Table 4: Impact, Influence, Interaction, and Net Impact/Influence of Components in the Fintech Implementation Model

Dimensions	Factors	Impact	Receptivity	Interaction	Net Influence/Impact	Outcome
Underlying Infrastructure and Technical	C_{11}	0.467	0.44	0.907	0.0275	Influential
	C_{12}	0.421	0.465	0.886	-0.044	Influenced
	C_{13}	0.468	0.451	0.919	0.0165	Influential
Organizational Policy	C_{21}	0.581	0.604	1.185	-0.024	Influenced
	C_{22}	0.517	0.556	1.073	-0.039	Influenced
	C_{23}	0.599	0.55	1.149	0.0484	Influential
	C_{24}	0.583	0.568	1.152	0.0146	Influential
Products and Services	C_{31}	0.417	0.462	0.878	-0.045	Influenced
	C_{32}	0.455	0.39	0.845	0.0649	Influential
	C_{33}	0.433	0.453	0.885	-0.02	Influenced
Market Factors	C_{41}	0.472	0.459	0.932	0.013	Influential
	C_{42}	0.394	0.421	0.814	-0.027	Influenced
	C_{43}	0.44	0.426	0.866	0.0142	Influential
Marketing and Sales	C_{51}	0.583	0.603	1.187	-0.02	Influenced
	C_{52}	0.562	0.569	1.131	-0.006	Influenced
	C_{53}	0.539	0.597	1.135	-0.058	Influenced
	C_{54}	0.579	0.495	1.074	0.0846	Influential
Economic	C_{61}	0.646	0.53	1.176	0.116	Influential
	C_{62}	0.608	0.598	1.206	0.01	Influential
	C_{63}	0.634	0.715	1.348	-0.081	Influenced
	C_{64}	0.635	0.68	1.316	-0.045	Influenced
Human Resources	C_{71}	0.471	0.459	0.93	0.0121	Influential
	C_{72}	0.387	0.405	0.792	-0.019	Influenced
	C_{73}	0.459	0.453	0.912	0.0065	Influential
Ecosystem	C_{81}	0.544	0.545	1.089	-6.00E-04	Influenced
	C_{82}	0.528	0.527	1.055	0.0009	Influenced
	C_{83}	0.526	0.526	1.053	-3.00E-04	Influenced

According to this finding, for success in the strategic implementation of fintech, banks depend on strategic alliances and cooperation with FinTechs, and managers must support this collaboration and develop a clear vision. Additionally, within the product and service dimension, "product adaptability", "security and privacy protection" and "product diversity" are the most influential factors, respectively. This implies that offering diverse services within the fintech financial system is related to the ease of integrating these services with other technologies.Next, to determine the relative importance of dimensions and components, we used the Fuzzy Analytic Network Process (ANP) based on Fuzzy DEMATEL. For this purpose, we normalized the general DEMATEL relationship matrix for the ANP input process using Equation 3, and then the normalized matrix converged based on $\lim_{h\to\infty}(\mathbf{W}^w)^h$ the power of 11. All values in the boundary matrix were obtained as convergent, and the results for the weights of dimensions and components were determined. These findings are presented in Table (5):

$$T_c = \frac{t_{c\,nm}}{\sum_j^m t_{c\,ij}}, i = 1, 2, \dots, m; \quad j = 1, 2, \dots, n \tag{3}$$

Table 5: Weights and Relative Importance of Dimensions and Components of the Fintech Implementation Model in the Banking-Financial Sector

Dimensions	Weights	Sub-Factors	local weight	Final weight
Infrastructure and Technical C1	0.151	C11	0.324	0.049
		C12	0.347	0.0523
		C13	0.329	0.0496
Organizational Policy C2	0.086	C21	0.274	0.0237
		C22	0.249	0.0215
		C23	0.234	0.0202
		C24	0.243	0.021
Products and Services C3	0.218	C31	0.371	0.0811
		C32	0.291	0.0635
		C33	0.338	0.0738
Market C4	0.078	C41	0.368	0.0288
		C42	0.321	0.0252
		C43	0.311	0.0244
Marketing and Sales C5	0.179	C51	0.282	Jan-00
		C52	0.253	0.0452
		C53	0.262	0.0468
		C54	0.204	0.0364
Economic C6	0.102	C61	0.204	0.0208
		C62	0.241	0.0245
		C63	0.288	0.0294
		C64	0.268	0.0273
Human Resources C7	0.132	C71	0.358	0.0471
		C72	0.271	0.0356
		C73	0.371	0.0488
Ecosystem C8	0.054	C81	0.341	0.0183
		C82	0.33	0.0177
		C83	0.329	0.0176

The findings in Table (5) indicate that the highest weight related to the "Products and Services" dimension is 0.218 in fintech implementation. This finding is also consistent in the DEMATEL method, as this dimension is also the most affected and weakest in fintech implementation and should be given more importance. Among the components, "Product and Service Diversity", "Security and Privacy Protection", "Adaptability of Products and Services", "Creating and Sharing Platforms" and "Service and Product Delivery Time" are ranked first to fifth in importance for the implementation of fintech in the financial-banking system. Based on these findings, emphasis is placed on the importance of designing and providing services tailored to customer needs in fintech implementation; otherwise, customers will use traditional banking services, and fintech implementation will face failure. Therefore, banks need to

identify customer needs and offer diverse, high-quality, secure, and timely services in line with customer expectations.

5 Discussion and Conclusions

In the context of implementing fintech in the financial-banking system, this research was conducted with the aim of identifying and determining the relationships and impact factors, as well as prioritizing the dimensions and components of fintech implementation in banks. To achieve this objective, a mixed-method approach was employed, including qualitative content analysis and a quantitative phase using the fuzzy DANP. Data from both the qualitative and quantitative phases were collected and analysed in the year 2024.The findings from the qualitative section revealed that for the implementation of fintech, banks should focus on eight dimensions: "Infrastructure and Technical", "Organizational Policy", "Products and Services", "Market", "Marketing and Sales", "Economic", "Human Resources" and "Ecosystem." The innovation of this study lies in helping banks identify and emphasize the dimensions of Products and Services, Market, and Marketing and Sales in fintech implementation, which have been less emphasized in previous studies. This finding indicates that focusing solely on technologies does not guarantee successful fintech implementation; instead, managers must also pay attention to the market and customer needs. The findings from the impact analysis of dimensions and components, using Fuzzy DEMATEL method, showed that the dimensions "Ecosystem", "Market Factors", "Organizational Policy," "Economic," "Human Resources," "Infrastructure and Technical", "Marketing and Sales" and "Products and Services" are impactful in improving fintech implementation, in that order. This finding indicates that the "Products and Services" dimension is the most affected in the implementation of fintech in the financial-banking sector. The success of fintech implementation is dependent on the characteristics of the "Products and Services" dimension. This result was obtained because banks are still not fully aware of customer needs and desires, while the demand for financial services has drastically changed with the growth of technology. Therefore, considering the rapid changes in technology, banks need to enhance their ability to provide services that meet customer needs. Products should be diverse and offer financial services for various segments. There should be adaptability in products and services, while ensuring that products and services maintain customer privacy and provide complete security. In addition, the "Ecosystem" dimension has been found to be the most influential in the implementation of fintech in the financial-banking sector. Therefore, it should be a priority for decision-making by managers. To improve this dimension, focus should be placed on the relationships between the components of this dimension. This result indicates that the political, social, and economic environment is crucial in the development and implementation of new technologies such as fintech in Iran. To enhance this dimension, it is suggested that the Iranian government should support the implementation of fintech technologies in banks and create stimulating regulations for their growth and development. The regulations should not be cumbersome, but should effectively protect the rights of customers and organizations. Additionally, it is recommended that collaboration among government agencies be established to create infrastructure for fintech development, and that there be cooperation between decision-making bodies (such as cyber police and ministries).In the second part of this research, the fuzzy Analytic Network Process based on DEMATEL method was used to determine the relative importance of dimensions and components. The findings of this method indicated that the component "Product and Service Diversity" has the highest importance in fintech implementation compared to

other components. This result shows that customer needs are dynamic due to rapid changes in information technology, and customers are seeking diverse and varied services. Therefore, for successful fintech implementation, banks and FinTech need to focus on providing diverse and innovative services to address the majority of customer needs. In this regard, it is suggested to decision-makers that for offering appropriate and timely services to customers, a strategic alliance based on win-win cooperation between FinTech and banks should be established. This collaboration will help in identifying customer preferences and designing and providing tailored and innovative services to meet their needs. Additionally, banks should aim to offer efficient facilities and operations for users and customers so that everyone can benefit; thus, it is recommended to develop financial and banking services accessible to all segments of society. In other words, services should be more accessible, considering factors such as demographic pyramids, cultural issues, etc .Additionally, "Security and Privacy Protection" was identified as the second most important component in fintech implementation. This result indicates that providing services on platforms with high security and preventing the theft of customer information is a key factor for success in fintech implementation. Nowadays, hackers access financial systems and software, gaining access to financial and private secrets, and stealing information and accounts. As a result, customers are increasingly concerned about using high-security software, and banks need to offer solutions to prevent and address fraud. Therefore, banks and FinTech must prioritize security and privacy protection in their financial technology software. To improve security and privacy in fintech implementation, it is recommended that bank and fintech managers consider the necessary technical and financial infrastructure to ensure software security. Additionally, appropriate planning, such as improving staff skills to identify security threats and implementing control measures, will be beneficial. Identifying security threats and enhancing staff skills for risk management is also important. Implementing strong security plans and adhering to global standards to improve both technical and human security systems, such as mitigating the risk of information disclosure by human resources, can be effective in enhancing security and privacy protection. The component "Adaptability of Products and Services" was ranked third in importance for fintech implementation. This result indicates that fintech technology should be easily compatible with other technologies, such as smartphones. Today, various technologies are involved in banking and financial activities. Therefore, it is expected that interoperability and compatibility between these technologies will be well established so that customers can have better access to their needs. To improve this component, it is suggested that managers consider compatibility with other operational technologies when designing financial services software for effective fintech implementation. This interaction and connectivity will allow customers to access a broader range of services.

The findings of our study had demonstrated that the ecosystem is very influence in implementing FinTech. In this regard, the study of Mohammadi et al [46] indicated that policymaking and capacity building are Very important factors in implementing FinTech, which is in line with our study. Also, Nalluri and Chen [33] in their study introduced weak government regulations and inadequate infrastructure as challenges to implementing FinTech. Also, Kukreja et al [38] consider the development of FinTech to be due to changes in financial and support policies. Another factor is emphasized in our research is infrastructure and technology. In this regard, the study by Kajla et al [34] also points to the role of the technology dimension in the success of FinTech. Bouteraa et al [35] also emphasize that FinTech technology needs infrastructure to be easily accessible to everyone. Lestari and Rahmanto [36] consider the most important challenges in implementing FinTech to be investment in software and hardware. Therefore, many studies emphasize the role of infrastructure and technology in implementing FinTech. In addition, the role of economic factors has also been highlighted in our study. In this regard,

domestic studies such as Mohammadi et al [46] on facilities and incentives; and Sharifi and Karimi [21] On financial factors such as income and expenses in the development of financial technology in the banking industry and fintech , and Zalan and Toufaily [40] on investment in fintech companies emphasize. The results of all these studies show that financial factors are important in the implementation of fintech.Regarding the human resource factor, the study of Wu & Kao [47] has shown that organizations with creative thinking and trained employees can offer flexible work arrangements that can improve organizational performance. Moreover, Mohammadi et al [46] have also have shown that training and culture building are effective in implementing FinTech. Horváth et al. (2022) also have emphasized that human resource challenges such as poor sales ability and incomplete knowledge of regulations are among the challenges of FinTech in communication and cooperation between banks.This study has limitations, such as the analysis based on expert opinions, which may introduce inherent biases and limit the generalizability of our findings. Additionally, the specific context of this study requires careful consideration when applying the findings to state-owned and private banks. We recommend that various studies be conducted to address these limitations and strengthen future research. Furthermore, since "Products and Services" is the most important dimension of fintech implementation, it is suggested that researchers explore the commercialization of innovative products for fintech. Additionally, for marketing and sales, it is recommended to design strategies based on the future outlook of fintech businesses.

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