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Original Research Article

E-Banking Progress Index (E-BPI)

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The technological revolution has spread over today's world, and it is clearly seen in banking, especially electronic banking. E-Banking has many dimensions, criteria, and components, and judging its progress based on dimensions leads to difficulty and bias. There is also a lack of comprehensive information references in the literature. Therefore, introducing a combinational index to accurately assess its progress is inevitable. In this research, the E-Banking Progress Index (E-BPI), which focuses on the infrastructures and the tools of e-banking and has five dimensions: Technical and Communicational Infrastructures; Services; Cultural-Educational Infrastructures; Security and Supervision; and Legal-Regulatory Infrastructures is created.
It also has several applications in investigating the progress of e-banking in a bank or a country and comparing it among banks or countries. This research, using Analytic Hierarchy Process (AHP), leads to the introduction of a combinational index to measure the progress of e-banking, which is able to analyze its strength and weakness. E-BPI provides a score between 0 and 1. The more the score, the stronger the e-banking is.

Keywords: Electronic Banking, Technological Revolution, Combinational Index, Analytic Hierarchy Process (AHP).
JEL Classification*:* E51, E59, G21, L63, L81

1 Introduction

Today's world is a digital world. ICT is present in all day-to-day human affairs, and most countries have changed their monetary, financial, and administrative structures. The structure of the development of any country without the presence of information and communication technology is unfindable. One of the basic requirements of e-commerce in any country is the main platform for fund exchange, namely, electronic banking. The entry of banks into the vast field of ICTs allows traditional banking to be replaced by banking-based technology (Khadem Alizadeh et al., 2016). E-banking is

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the use of advanced software and hardware technologies based on network and telecommunication to exchange financial resources and information electronically, with no need for the physical presence of the customer in the branch (Ahmadi and Khandan Saviri, 2016). The existence of different dimensions, criteria, and components in e-banking and difficulty in its evaluation reveals the necessity of a combinational index in this area. Efforts have been made in the world to reach an index for measuring the growth rate of e-banking, but the lack of an appropriate combinational index and the lack of comprehensive information references, along with the difficulty of assessing progress in this area based on existing indexes, implies the need for research to introduce the E-Banking Progress Index (E-BPI) more than ever.

A combinational index in e-banking, combining different dimensions and criteria helped by an analytic approach, can provide a great deal of accurate evaluation of the system. This research has paid special attention to infrastructures, commissions, and qualifications. After studying the 2008 World Bank's report on measuring the development of payment and research systems that have been followed up around the world in this area, we have introduced the E-Banking Progress Index (called E-BPI). By determining Analytic Hierarchy Process (AHP), we have determined the importance coefficient of each dimension and criterion. This research studies the relation among e-banking variables and creates a practical framework for this.

In this research we have been looking for answers to these questions:

1) What is a suitable index to assess the e-banking progress in banks or countries?
2) What are its dimensions and criteria?
3) What is the appropriate weight for these dimensions and criteria?

The process of creating E-BPI is shown in Table 1:

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Table 1
The process of creating E-BPI

No.	Steps	Reference	Research Method
1	Defining e-banking	the World Bank website and Central Bank of Iran	Studying the references
2	Analyzing the dimensions of e-banking	the World Bank website and Iranian bank science professionals	Studying the references and interviewing experts
3	Identifying the criteria of each dimension	the World Bank website and Iranian bank science professionals	Studying the references and interviewing experts
4	Identifying the components of each criterion	the World Bank website and Iranian bank science professionals	Studying the references and interviewing experts
5	Extracting the importance coefficients of dimensions and criteria	Iranian bank science professionals and experts	Distributing a pairwise comparison questionnaire and using AHP
6	Achieving the final importance coefficients	Expert Choice software	Using AHP
7	Obtaining the final index	Mathematical computation	Mathematical Methods

Source: Research Findings

Comparing E-BPI with the World Bank's report, we can mention the following differences:

1) The World Bank's report investigates the dimensions individually while combining the dimensions; E-BPI compares criteria and dimensions interacting with each other.
2) The World Bank's report does not analyze the country's status and just classifies them independently. On the other hand, E-BPI can analyze the strengths and weaknesses of an e-banking system.
3) The World Bank's report just takes the classification to the national level among countries, but E-BPI also provides a comparison in the firm (bank) level.

We continue this paper with literature review in Section 2. Then we explain the conceptual framework and the applied methods in Section 3. Finally we summarize the results in Section 4 which contains the conclusion.

2 Literature Review

Several studies have been conducted on e-banking worldwide to examine its various criteria and dimensions. Of the most important ones is the World Bank's report on measuring the development of payment systems on the

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countries level that we apply as the theoretical foundation of this research. In the following, we provide a brief review of some of them:

In 2002, a model named E-SERVQUAL was presented, which includes seven dimensions: efficiency, reliability, fulfillment, privacy, responsiveness, compensation, and contact. That research is based on the same papers written by academic researchers on online services, and by forming a framework for online stores, it studies the quality of their services. The first four dimensions are provided to evaluate the quality of online services from the customers' perceptions. The other ones are provided to evaluate the services that appear when customers have questions or run into problems. (Zeithaml et al., 2002)

In 2003, Wolfinberger and Gilly presented a model to assess the quality of online e-store services, which examines the quality of the online salespeople's perception and feeling by asking them: Which characteristics are most important in judging quality, satisfaction, and loyalty? Their analysis suggested that four factors -website design, fulfillment/reliability, privacy/security, and customer service- are strongly predicting customer judgments of quality and satisfaction, customer loyalty, and attitudes toward the website. (Wolfinbarger and Gilly, 2003)

In 2007 and 2008, the World Bank investigated the development of payment systems and launched a report in 2008. That was based on the data obtained from 142 countries' responses to the Global Payment Systems Survey carried out by Bank's Payment Systems Development Group (PSDG). Country-by-country answers to each of the questions included in the survey have been published as an appendix to the World Bank publication "Payment Systems Worldwide: a Snapshot. Outcomes of the Global Payment Systems Survey 2008". This exercise also aims at providing a broad picture of the level of development of each country with regard to payment systems. In essence, this measurement exercise intends to synthesize a complex set of qualitative and quantitative payment system characteristics into categories reflecting various levels of development. In turn, the categories reflect a range of scores for each component of a national payment system that is measured. Specific scores are given to individual payment system features, and a total score is then calculated for each area subject to measurement. As a result, this exercise focuses exclusively on four components of the national payments system as follows: 1) legal and regulatory framework; 2) large-value payment systems; 3) retail payment systems, and 4) payment system oversight. For all the components, and where applicable also for the relevant subcomponents, countries are classified into four different categories reflecting a certain level of development: 1) high; 2) medium-high; 3) medium-low, and 4) low.

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According to the PSDG's methodology, countries that fall in each of these categories are then listed in strict alphabetical order. (Cirasino and Garcia, 2008)

In 2010, Natarajan et al. valued customer-selected technologies in microfinance through AHP in national and private banks of India. The dimensions of this study are: 1) Purpose (Fund Transaction; Availing Information; Service Requests); 2) Perceived Risk (Performance Risk; Security Risk; Financial Risk; Time Risk; Psychological Risk; Social Risk); 3) Benefits (Time saved; Money saved; Less physical efforts; Round the clock banking); 4) Requirements (Technical know-how; Equipment's; Experience; Language Skills), which are combined with the following instrumental dimensions: i) ATM; ii) Internet Banking iii) Mobile Banking. (Natarajan et al., 2010)

In 2012, Bazaei and Dehghanpour, distributing questionnaires among macro managers, middle managers, and Iranian banking experts, determined indexes to investigate the function of e-banking among 13 governmental and private banks in Iran. The indexes are studied with two dimensions as follows and ranked Iranian banks accordingly: 1) Quantitative indexes for electronic tools (i: combinational indexes for cards; ii: combinational indexes for equipment; iii: combinational indexes.); 2) Qualitative indexes for electronic tools (i: the status of POS conflict; ii: the status of successful transactions; iii: the status of noncash transactions). (Bazaei and Dehghanpoor, 2012)

Nasrabadi et al. (2014) considered a variety of dimensions of e-banking at the branch level of Sina Bank in Iran and assigned a weight to these dimensions as follows: 1) Systematic responsiveness and efficiency weighs 0.345; 2) Quality and security of services and information weighs 0.276; 3) Customer orientation weighs 0.169; 4) Design and implementation of electronic services weighs 0.121; 5) Usage of Web 2.0 tools weighs 0.089. Finally, they ranked the selected branches of Sina Bank into 5 levels A, B, C, D, and E. (Nasrabadi et al., 2014)

In 2015, an article titled "New Dimensions of E-Banking in Today's Scenario" by Radhadevi was published, which underscored the importance of 24/7 electronic financial transactions in today's human daily life. Companies that do not use e-banking are at a competitive disadvantage in an information-driven business climate. Automating routine bill payments minimizes the need to visit bank branches physically. E-banking, also, solve numerous payment problems in banks. Smartphone technologies and online banking are considered new dimensions of e-banking. The security of financial transactions is the most complicated challenge that needs to be addressed.

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However, a growing trend in the number of mobile transactions can be seen between 2007 and 2013, and based on this paper, more than %43 of people apply e-banking, and the request for Cheque books has dropped. (Radhadevi, 2015)

In 2015, another study was conducted on measuring the quality of electronic services in order to clarify the deployment of various applications of informational and communicational technology, including e-banking and its components. Then using eSERVQUAL model and NAPIS techniques, its variables are analyzed. The statistical population of the study is the Iranian Banking and academic experts. The dimensions studied in this research include efficiency, accessibility to the system, fulfillment, privacy, accountability, compensation, and contact. This study shows that the accessibility and ease of the use of the system cause a higher percentage of customers' satisfaction. (Farid and Dehghan, 2015)

In 2015, another research was also done titled "Ranking the Technical Dimensions of E-banking Service Quality Evaluation Models using Analytical Hierarchy Process." It has 8 dimensions as follows: Security; Reliability; Fulfillment (information, operations); Efficiency; Information Availability; Outcome Quality; System Integration; Technical Adequacy. The statistical population of the research is banking professionals and experts. Using questionnaires and AHP, they determined the coefficient among these dimensions. According to the numeric results, security, technical adequacy, and reliability have the highest importance, and Outcome quality has the lowest importance. (Yaghubi and Seyedin, 2015)

In 2016, a study titled "the Evaluation of the Performance of Electronic Banking Services (Internet Banking, Mobile Banking, and Telephone Banking) a Case Study of Customers of Selected Branches of Saderat Bank in Tehran" evaluated the performance of electronic services from the customers of Iranian Saderat Bank's point of view. To investigate the performance of electronic services to determine customers' satisfaction with the mentioned services, using descriptive research method through Likert Five Choice questionnaires, using the binomial test, the research hypotheses were evaluated and using the correlation test, the relation between the dimensions of electronic services and customers' satisfaction is reviewed. The target population consisted of all clients of Saderat Bank in Tehran, who were randomly assigned 130 questionnaires. The research findings indicate a positive and significant relationship between e-services and customers' satisfaction from Iranian Saderat Bank. (Khadem Alizadeh et al., 2016)

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As it is deduced from the literature review in this field, the lack of a combinational index that addresses various infrastructures and dimensions of e-banking, the difficulty of assessing the progress of e-banking based on existing indexes, and the lack of comprehensive information resources in this field make it more necessary to carry out this research. Therefore, presenting E-BPI, we try to eliminate the limitations in other researches. From a practical point of view to e-banking, we facilitate the comparison of the progress of e-banking among banks and countries. Moreover, we can also study the state of different dimensions individually by analyzing the numerical results achieved from E-BPI.

3 Conceptual Framework

3.1 Introducing the Index

The E-Banking Progress Index (E-BPI) is applied to assess the progress of e-banking in countries or banks in a period or at a point in time. It has several applications as follows:

Applications at National-Level: There are two applications to evaluate e-banking progress in countries as follows:

- Comparing the progress of e-banking in different countries at a point in time;
- Identifying the progress of e-banking in a country in a period of time.

In this case, e-banking in countries is studied through five dimensions:

1) Technical and Communicational Infrastructure;
2) Services;
3) Cultural and Educational Infrastructure;
4) Security and Oversight;
5) Legal and Regulatory Infrastructure.

Applications at Bank-Level: There are two other applications to evaluate e-banking progress at the level of banks:

- Comparing the progress of e-banking at the banks of one country against each other at a point in time;
- Identifying the progress of e-banking at a bank in a period.

But in this case, e-banking of the banks is studied through four dimensions:

1) Technical and Communicational Infrastructure;
2) Services;
3) Cultural and Educational Infrastructure;
4) Security and Oversight.

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3.2 Computing the Index

In this section, the mathematical computation of E-BPI along with its dimensions, criteria, and components are described in detail.

3.2.1 Technical and Communicational Infrastructure

The beginning of the e-banking process is possible through communication with the platforms in this field. The newer and safer communication platforms, the more trust will be created. Therefore, correct and accurate correlation between the components of an e-banking system is possible with appropriate technical and communicational infrastructure. This dimension has the following criteria and components:

1) Communications and Telecommunications: Its components include communication, telecommunication, and network infrastructure, satellite systems, the Internet, fiber optic lines, mobile and telephone networks, and so on. If these infrastructures are present and they are up to date, a score of 1 will be assigned; if they are incomplete, a score of 0.5 will be given; or if there are not any, a score of 0 will be assigned.
2) Software: Its components include: (The average of the following component scores determines the score of this criterion.)
    1) Applying Core banking. If it exists, a score of 1 is assigned; otherwise, a score of 0 is assigned;
    2) Applying Core-appropriate software systems. If it exists, a score of 1 is assigned; otherwise, a 0 is assigned.
3) Hardware: Its components include: (The average of the following component scores determines the score of this criterion.)
    1) Developing the hardware of banking systems appropriate to the current needs. If it is up-to-date, a score of 1 will be assigned; if it is under development, a score of 0.5 will be given; or if it does not exist, a score of 0 will be assigned;
    2) Applying appropriate backup servers. If they are up-to-date, a score of 1 will be assigned; if they are incomplete, a score of 0.5 will be given; or if they do not exist, a score of 0 will be assigned.
4) Connecting to the National Banking Communication Network. Connecting to the country's internal banking network, a score of 1 will be assigned; otherwise, a score of 0 is assigned.
5) Connecting to the International Banking Communication Network. Connecting to the world banking network, a score of 1 will be assigned; otherwise, a score of 0 is assigned.

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6) Social Networks. The activity-based infrastructure through social networks and the effective presence in this area lead to a score of 1; otherwise, a score of 0 is assigned.

3.2.2 Services

The availability of e-banking tools and services enables customers to telecommunicate with the bank. The greater the variety, quality, and user-friendliness of these tools and services, the more customers in this area possibly are attracted, and the less their referral to the bank branches will be. This dimension has the following criteria and components:

1) Variety of Tools: Number and variety of ATMs, Bank kiosks, Pin pads, POSs, Internet Banking, Mobile Banking, Telephone Banking, Various Banking Cards, Electronic Money, Specialized Electronic Systems for Companies and Public/Private Organizations, RTGS System and so on are the components to be considered by this criterion. A score of 0.1 is assigned to each tool for a maximum of 10 tools (the score is between 0 and 1).
2) Quantity: You can measure the quantity with the following components: (the average score of the following components determines the score of this criterion.)
    1) The ratio of the number of electronic transactions to the number of total banking transactions. We assign this ratio as the score;
    2) The relative frequency of the use of electronic devices. Studying a bank (or a country) in a period of time, the number of customers of e-banking per year is divided by the number of customers of e-banking in the base year - the year in which the most customers have used e-banking while studying a bank (or a country) at a point in time, the number of customers of e-banking per bank (or country) is divided by the number of customers of e-banking in the base bank (or country) - the bank (or country) where the most customers have used e-banking.
3) Quality: The following components are used in order to measure the quality: (The average score of the following components determines the score of this criterion.)
    1) The ratio of the number of successful electronic transactions to the total number of electronic transactions;
    2) Accessibility: means the duration of the activity of the e-banking system during 24 hours of a day. For each minute the system is down (up to maximum 10 minutes), we reduce 0.1 of the score one (for more than 10 minutes being down, the score will be 0).

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4) Responsiveness: You can measure responsiveness through the following components: (The average score of the following components determines the score of this criterion.)
   1) By phone: For Conversation and SMS, only during office hours, a score of 0.5 is assigned, and 24 hours a day, a score of 1 is assigned;
   2) By net: Online, Offline, Social Networks. (Online: 0.25; Offline: 0.25; Social Networks: 0.25; all together, a score of 1 is assigned.)

3.2.3 Cultural and Educational Infrastructure

The trend towards e-banking requires training in the field of customers and employees to get a clear view without worrying about changes in e-banking. The next issue is adapting to new tools and systems of people's culture and acceptance, and the localization of these new tools should be provided for customers. This dimension has the following criteria and components:

1) Staff Training: (The average score of the following components determines the score of this criterion.)
   1) The number of trained employees in e-banking divided by the total number of employees in e-banking;
   2) Staff training hours per year (bank or country) are divided by staff training hours in the base year (bank or country). The base year (bank or county) is the year (bank or county) in which the most training hours are provided in e-banking.
2) Customer Training: Providing customer guidance on electronic ports (provided in some ports, a score of 0.5 is assigned, provided in all ports, a score of 1 is assigned, otherwise, a score of 0 is assigned.)
3) Cultural Acceptance: (The average score of the following components determines the score of this criterion.)
   1) The growth rate of the adopted electronic tools for the customer. The number of customers using e-banking per year (bank or country) is divided by the number of total customers in the base year (bank or country);
   2) The rate of the localized tools in e-banking. This component is computed by examining the process of localizing the electronic tools in the case under study, which will assign a value between 0 and 1 to the score.

3.2.4 Security and Oversight

In the e-banking platform, financial transactions need to be established in a secure environment. Transaction from origin to destination must be transferred so that the customer and the service provider do not have any

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security concerns. When we provide banking services using ICT infrastructure, and in a secure environment, we reach the proper definition of e-banking. Essentially, e-banking development brings more clarity to financial transactions. Monitoring such a system increases the security of information and disappoints cyber hackers. This dimension has the following criteria and components:

1) Software Security: (The average score of the following components determines the score of this criterion.)
    1) Security equipment to avoid infiltration of banking systems and hacker and virus attacks. By investigating security systems, a number between 0 and 1 is assigned to this component;
    2) Application layer security devices, such as Web Layer Firewalls. By investigating security systems, a number between 0 and 1 is assigned to this component;
    3) Virtual keyboard. If there is one, a score of 1 is assigned; otherwise, a score of zero is assigned;
    4) Token: Multi-factor authentication has a score of 1; two-factor authentication has a score of 0.5, and otherwise 0;
    5) Financial fraud avoidance through training and security alerts in payment portals and systems. Depending on the number of electronic ports that have security training, a score between 0 and 1 is assigned;
    6) Digital signature. If there is one, a score of 1 is assigned; otherwise, a score of 0 is assigned.
2) Hardware Security: (The average score of the following components determines the score of this criterion.)
    1) Location of the ATMs and Kiosks of branches and equipping them with security cameras. If these facilities are available, a score of 1 is assigned; otherwise, a score of 0 is assigned;
    2) Host and Core security in terms of location: If they are in a safe place, a score of 1 is assigned; otherwise, a score of 0 is assigned;
    3) Applying safe hardware, e.g., HSM: Hardware Security Module. By investigating security systems, a number between 0 and 1 is assigned to this component;
    4) Implementation of ISO27K standards at data centers. By investigating security systems, a number between 0 and 1 is assigned to this component;
    5) Possession of a mirror site. If there is one, a score of 1 is assigned; otherwise, a score of 0 is assigned;

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6) Possession of disaster recovery site. If there is one, a score of 1 is assigned; otherwise, a score of 0 is assigned.

3) Internal Monitoring Systems: (The average score of the following components determines the score of this criterion.)
   1) Electronic monitoring systems. If there is one, a score of 1 is assigned; otherwise, a score of 0 is assigned;
   2) Remote inspection of electronic operations. If there is one, a score of 1 is assigned; otherwise, a score of 0 is assigned.

4) Inclusive Regulatory Systems: (The average score of the following components determines the score of this criterion.)
   1) Operating national oversight systems and regulations, e.g., Central Bank regulations and Cyberspace cops regulations. By investigating security systems, a number between 0 and 1 is assigned to this component;
   2) Operating international oversight systems and regulations, e.g., Money Laundering and Terrorist Financing laws. A number between 0 and 1 is assigned to this component by investigating security systems.

3.2.5 Legal and Regulatory Infrastructure

Document affairs and relying on documentary information in the banking system have been established in order to prevent misuse, identify possible violations, and efficiently deal with them. Its failure leads to the collapse of the ruling order in this area. The legal system governing electronic documents must safeguard the security of e-banking documents and information and guarantee their accuracy, integrity, confidentiality, and permissible accessibility. In this regard, the necessity of creating legal and regulatory infrastructure to avoid confusion and protect material and moral rights has major importance in this area. This dimension has the following criteria and components:

1) Quality of Laws and Regulations: The components that can be measured with this criterion are:
   1) Existence of supportive and fundamental laws and regulations, such as e-commerce law and computer crime law and Central Bank regulations;
   2) Avoidance of restrictive regulations;
   3) Stability of rules and regulations;
   4) Clarity of network settings and regulations (bilaterally and multilaterally);
   5) Clarity of the electronic payment process;

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6) Clarity of final settlement schedule.

By investigating the existence of the laws and regulations of each component, a score between 0 and 1 is given. The score of this criterion is the average of the component scores.

2) Executive Guarantees of Laws and Regulations: The components that can be measured with this criterion are:
   1) Protecting financial information of individuals in e-banking systems and privacy;
   2) Registering and legal citation ability of electronic transactions process.

   By investigating the guarantees of the laws and regulations of each component, a score between 0 and 1 is given. The score of this criterion is the average of the component scores.
3) Interaction and Coordination of Relevant Legal Entities: The measurable criterion of this component is interaction with the judiciary, responsible organizations for anti-money laundering, the Central Bank, ICT-related ministries, etc. A score between 0 and 1 is given to each component by investigating this criterion.

In short, this categorizing is shown in Table 2:

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Table 2
Table of E-Banking Progress Index (E-BPI)

Level of Index	**National-Level Index**		
Dimensions	**5** **Legal and Regulatory Infrastructure**		
Criteria	**Quality of Laws and Regulations**	**Executive Guarantees of Laws and Regulations**	**Interaction and Coordination of Relevant Legal Entities**
Components	a) Existence of supportive and fundamental laws and regulations, such as e-commerce law, computer crime law, and Central Bank regulations b) Avoidance of restrictive regulations c) Stability of rules and regulations d) Clarity of network settings and regulations (bilaterally and multilaterally) e) Clarity of the electronic payment process f) Clarity of final settlement schedule	a) Protecting financial information of individuals in e-banking systems and privacy b) Registering and legal citation ability of electronic transactions process	Interaction with the judiciary, Responsible organizations for anti-money laundering, the central bank, ICT-related ministries, etc.

(continued)

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Table 2 (continues)

Level of Index	**National-Level Index**			
	Bank-Level Index			
Dimensions	**4** **Security and Oversight**			**4** **Security and Oversight**
Criteria	**Software Security**	**Hardware Security**	**Internal Monitoring Systems**	**Inclusive Regulatory Systems**
Components	a) Security equipment to avoid infiltration of banking systems and hackers and virus attacks b) Application layer security devices, such as Web Layer Firewalls c) Virtual keyboard d) Token(Multi Factor Authentication) e) Financial fraud avoidance through training and security alerts in payment portals and systems f) Digital signature	a) Location of the ATMs and Kiosks of branches and equip them with security cameras b) Host and Core security in terms of location c) Applying safe hardware(e.g. HSM: Hardware Security Module) d) Implementation ISO27K standards in data centers e) Possession mirror site f) Possession disaster recovery site	a) Electronic monitoring systems b) Remote inspection of electronic operations	a) Operating national oversight systems and regulations (e.g. Central Bank regulations and Cyberspace cops regulations) b) Operating international oversight systems and regulations (e.g. Anti-money laundering laws)

(continued)

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Table 2 (continues)

Level of Index	**National-Level Index**						
	Bank-Level Index						
Dimensions	**2** **Services**				**3** **Cultural and Educational Infrastructure**		
Criteria	**Variety of Tools**	**Quantity**	**Quality**	**Responsiveness**	**Staff Training**	**Customer Training**	**Cultural Acceptance**
Components	Number and promotion of ATMs, Bank kiosks, Pin pads, POSs, Internet Banking,, Mobile Banking, Telephone Banking, Various Banking Cards, Electronic Money, Specialized Electronic Systems for Companies and Public-Private Organizations , RTGS system, and so on	a) The ratio of the amount of electronic transactions to total banking transactions b) The relative frequency of the use of electronic devices	a) The ratio of the number of successful electronic transactions to total electronic transactions b) Accessibility, i.e. the duration of the activation of the e-banking system (24 hours a day)	a) By phone (Conversation, SMS) b) By net (Online, Offline, Social Networks)	hours of training as well as the extent of training (the rate of the number and hours of trained staff)	The ability to provide guidance to customers on electronic portals and the possibility of contacting the support department in case of necessity	The growth rate of the newly adopted electronic tools for customers and the ratio of the localized tools

(continued)

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Table 2: Table of E-Banking Progress Index(E-BPI) (continues)

Level of Index	**National-Level Index**					
	Bank-Level Index					
Dimensions	**1** **Technical and Communicational Infrastructure**					
Criteria	**Communications and Telecommunicatio**	**Software**	**Hardware**	**Connecting to the National Banking**	**Connecting to the International Banking**	**Social Networks**
Components	Existence of communication, telecommunication and network infrastructure, satellite systems, the Internet, fiber optic lines, mobile and fixed-telephone networks, and so on	a) Applying Core Banking b) Applying efficient software systems	a) Developing the hardware of banking systems fit to the needs of the day b) Applying appropriate backup servers	Connecting or not connecting to the country's internal banking network	Connecting or not connecting to the world banking network such as SWIFT	Provision of activity-based infrastructure through social networks and the effective presence in this area

***Source*:** Research Findings

Remark1: To calculate E-BPI at the national level, all dimensions, criteria, and components are studied, but at the bank level, we only study four dimensions, technical and educational infrastructures, services, cultural and educational infrastructures, and security and oversight (just including the first three criteria).

Remark2: The components of each criterion have the same weight (which sum up to 1). It is important to mention that each component is scored so that we gain numbers between zero and one. In the end, the final value of the index (discussed in section 3.4) lies between zero and one. The nearer this index to one, the more mature the e-banking is at the bank or country. If the index is near zero, it will indicate problems and immaturity.

3.3 Extracting the Importance Coefficient (Weight) of E-BPI Dimensions and Criteria

In this research, Analytical Hierarchy Process (AHP) is used to determine the coefficients of dimensions and criteria as well as to analyze the data. AHP is one of the most famous multi-purpose decision-making techniques invented by Thomas L. Saaty in the 1970s. This method can be used when decision-making practice has multiple options and decision criteria. The proposed criteria can be quantitative and qualitative. This method is based on paired comparisons. The AHP logic combines matrices derived from paired comparisons to make an optimal decision. Saaty (2012) has shown that an inconsistency ratio of 0.10 or less is acceptable to continue the AHP analysis. If the inconsistency ratio is greater than 0.10, it will be necessary to revise the judgments and correct them.

In this study, 40 senior managers and senior experts of the e-banking sector of Iran were selected judgmentally to determine the importance coefficients of the combinational index and, by designing a pairwise comparison questionnaire and distributing it, we determined the importance coefficients of E-BPI.

As stated in Section 3.1, the coefficients are determined according to the applications in two cases (national or bank-level), which are obtained using Expert Choice Software. The results are obtained in two cases of applications at the national or the bank level as follows:

3.3.1 Coefficients at the National Level

In this case, the final coefficients are calculated in order to compare the promotion of e-banking in different countries at a point in time or to identify the promotion of e-banking in a period. The final output of Expert Choice

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Software can be seen in Figure 1. The overall inconsistency is 0.07, which validates the results. The final importance coefficients of the index are shown in Table 3.

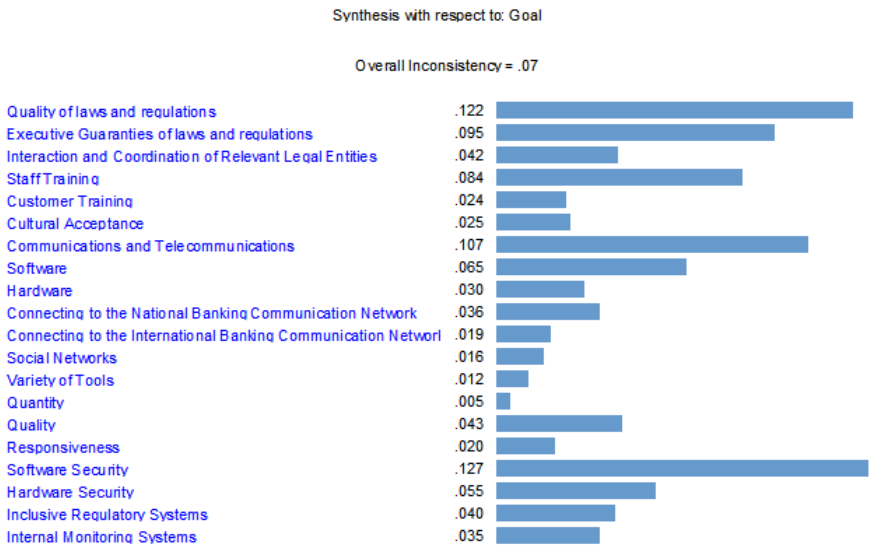

Figure 1. Output of Expert Choice Software (National-Level).
Source: Research Findings

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Table 3
Final Importance Coefficients of E-BPI (National-Level)

No	Dimensions	Criteria	Final Importance Coefficients
1	Technical and Communicational Infrastructure (0.272)[1]	Communications and Telecommunications(0.394)	0.129
		Software(0.237)	0.077
		Hardware(0.109)	0.036
		Connecting to the National Banking Communication Network(0.131)	0.043
		Connecting to the International Banking Communication Network(0.070)	0.023
		Social Networks(0.058)	0.019
2	Services (0.08)	Variety of Tools(0.154)	0.011
		Quantity(0.062)	0.004
		Quality(0.538)	0.038
		Responsiveness(0.246)	0.017
3	Cultural and Educational Infrastructure (0.132)	Staff Training(0.631)	0.063
		Customer Training(0.183)	0.018
		Cultural Acceptance(0.186)	0.018
4	Security and Oversight (0.256)	Software Security(0.495)	0.121
		Hardware Security(0.214)	0.052
		Internal Monitoring Systems(0.135)	0.033
		Inclusive Regulatory Systems(0.156)	0.038
5	Legal and Regulatory Infrastructure (0.260)	Quality of Laws and Regulations(0.471)	0.123
		Executive Guarantees of Laws and Regulations(0.366)	0.095
		Interaction and Coordination of Relevant Legal Entities(0.163)	0.042

Source: Research Findings

3.3.2 Coefficients at the Bank-Level

In this case, the final coefficients are calculated in order to compare the progress of e-banking in the banks of a country at a point in time or to identify the progress of e-banking in a bank in a period. The final output of Expert Choice Software can be seen in Figure 2. The overall inconsistency is 0.09, which validates the results. The final importance coefficients of the index are shown in Table 4.

[1] The numbers in parentheses show the coefficients of each dimension and criterion separately.

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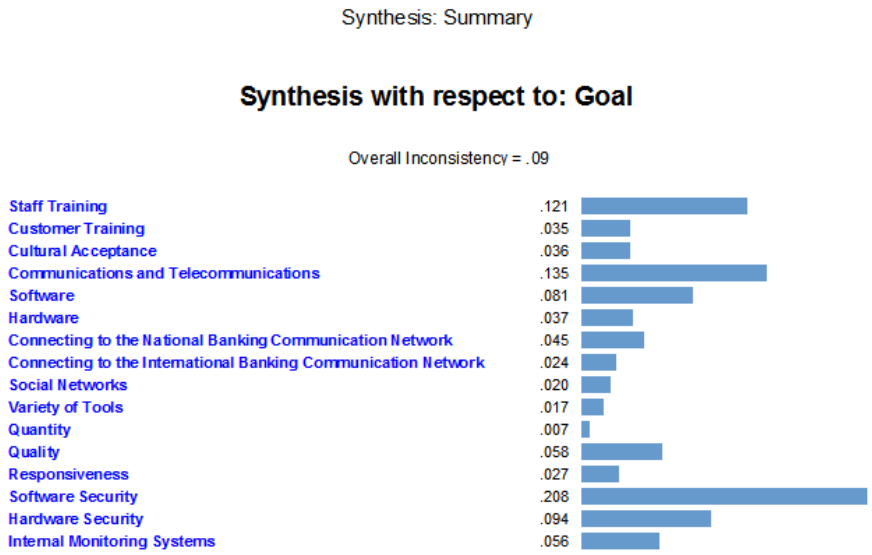

Figure 2. Output of Expert Choice Software (Bank-Level).
Source: Research Findings

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Table 4
Final Importance Coefficients of E-BPI (Bank-Level)

No	Dimensions	Criteria	Final Importance Coefficients
1	Technical and Communicational Infrastructure (0.341)	Communications and Telecommunications(0.394)	0.135
		Software(0.237)	0.081
		Hardware(0.109)	0.037
		Connecting to the National Banking Communication Network(0.131)	0.045
		Connecting to the International Banking Communication Network(0.070)	0.024
		Social Networks(0.058)	0.020
2	Services (0.108)	Variety of Tools(0.154)	0.017
		Quantity(0.062)	0.007
		Quality(0.538)	0.058
		Responsiveness(0.246)	0.027
3	Cultural and Educational Infrastructure (0.192)	Staff Training(0.631)	0.121
		Customer Training(0.183)	0.035
		Cultural Acceptance(0.186)	0.036
4	Security and Oversight (0.358)	Software Security(0.581)	0.208
		Hardware Security(0.263)	0.094
		Internal Monitoring Systems(0.157)	0.056

Source: Research Findings

3.4 The Final Calculation of E-BPI

Using the final importance coefficients and the calculation based on Table 2, we can study the progress of e-banking in a country or bank-level in different cases.

3.4.1 National Level

According to Table 2, each criterion is measured and multiplied by the corresponding final importance coefficients in Table 3; we achieve the score of each criterion of e-banking in a country. Then by adding up the scores of the criteria of each of five dimensions, we identify their scores. Finally, we sum up the scores of all dimensions to obtain the final index.

3.4.2 Bank Level

According to Table 2, each criterion is measured and multiplied by the corresponding final importance coefficients in Table 4; we achieve the score of each criterion of the e-banking in a bank. Then by adding up the scores of

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the criteria of each of four dimensions, we identify their scores. Finally, we sum up the scores of all dimensions to obtain the final index.

3.5 Case Study

This section presents a brief example of how to calculate the index and its results, which is completely given in Hosseini and Hafezi (2019). As that paper is written in Persian, a summary is provided here for the English-speaking readers to clearly represent the index's importance and its application.

This case study is related to the Keshavarzi Bank of Iran, which has been analyzed based on data from 2015 to 2017, computing the E-BPI. The results for the mentioned years are shown in Tables 5 to 7:

Table 5
E-Banking Progress Index of Keshavarzi Bank in 2015

No	Dimensions	Criteria	Computation of scores	Importance Coefficients	Multiplications	Index
1	Technical and Communicational Infrastructure (0.341)	Communications and Telecommunications	0.75	0.135	0.10125	0.2495
		Software	0.75	0.081	0.06075	
		Hardware	0.5	0.037	0.0185	
		Connecting to the National Banking Communication Network	1	0.045	0.045	
		Connecting to the International Banking Communication Network	1	0.024	0.024	
		Social Networks	0	0.020	0	
2	Services (0.108)	Variety of Tools	0.8	0.017	0.0136	0.05128
		Quantity	0.38745	0.007	0.00271	
		Quality	0.48656	0.058	0.02822	
		Responsiveness	0.25	0.027	0.00675	
3	Cultural and Educational Infrastructure (0.192)	Staff Training	1	0.121	0.121	0.15714
		Customer Training	0.5	0.035	0.0175	
		Cultural Acceptance	0.51775	0.036	0.01864	
4	Security and Oversight (0.358)	Software Security	0.45833	0.208	0.09533	0.21008
		Hardware Security	0.625	0.094	0.05875	
		Internal Monitoring Systems	1	0.056	0.056	
	Total					0.668

Source: Research Findings

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Table 6
E-Banking Progress Index of Keshavarzi Bank in 2016

No	Dimensions	Criteria	Computation of scores	Importance Coefficients	Multiplications	Index
1	Technical and Communicational Infrastructure (0.341)	Communications and Telecommunications	0.75	0.135	0.10125	0.25963
		Software	0.875	0.081	0.07088	
		Hardware	0.5	0.037	0.0185	
		Connecting to the National Banking Communication Network	1	0.045	0.045	
		Connecting to the International Banking Communication Network	1	0.024	0.024	
		Social Networks	0	0.020	0	
2	Services (0.108)	Variety of Tools	0.825	0.017	0.01403	0.06741
		Quantity	0.5089	0.007	0.00356	
		Quality	0.74255	0.058	0.04307	
		Responsiveness	0.25	0.027	0.00675	
3	Cultural and Educational Infrastructure (0.192)	Staff Training	0.615	0.121	0.07442	0.11416
		Customer Training	0.5	0.035	0.0175	
		Cultural Acceptance	0.61775	0.036	0.02224	
4	Security and Oversight (0.358)	Software Security	0.58333	0.208	0.12133	0.24
		Hardware Security	0.66667	0.094	0.06267	
		Internal Monitoring Systems	1	0.056	0.056	
	Total					0.6812

Source: Research Findings

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Table 7
E-Banking Progress Index of Keshavarzi Bank in 2017

No	Dimensions	Criteria	Computation of scores	Importance Coefficients	Multiplications	Index
1	Technical and Communicational Infrastructure (0.341)	Communications and Telecommunications	0.75	0.135	0.10125	0.26888
		Software	0.875	0.081	0.07088	
		Hardware	0.75	0.037	0.02775	
		Connecting to the National Banking Communication Network	1	0.045	0.045	
		Connecting to the International Banking Communication Network	1	0.024	0.024	
		Social Networks	0	0.020	0	
2	Services (0.108)	Variety of Tools	0.825	0.017	0.01403	0.0743
		Quantity	0.6508	0.007	0.00456	
		Quality	0.8441	0.058	0.04896	
		Responsiveness	0.25	0.027	0.00675	
3	Cultural and Educational Infrastructure (0.192)	Staff Training	0.642	0.121	0.07768	0.13093
		Customer Training	0.75	0.035	0.02625	
		Cultural Acceptance	0.75	0.036	0.027	
4	Security and Oversight (0.358)	Software Security	0.70833	0.208	0.14733	0.27383
		Hardware Security	0.75	0.094	0.0705	
		Internal Monitoring Systems	1	0.056	0.056	
	Total					0.74794

Source: Research Findings

The results of measurement of each dimension show that Keshavarzi Bank of Iran has taken an upward trend in the dimension of Cultural-Educational Infrastructure during 2017, after a downward trend during 2015 and 2016. After investigating, it was determined that the descent was the decline in investment in the education area in 2016. Other dimensions have been raised during the studied three years. The Technical and Communicational Infrastructure has a low and ascending slope. The Services also has a positive but decreasing slope, and finally, the Security and Oversight has a positive and ascending slope. Security and Oversight dimensions and Technical and Communicational Infrastructure having higher levels indicate the need for more attention and investment in these two dimensions for higher efficiency. You can see the results in Figure 3:

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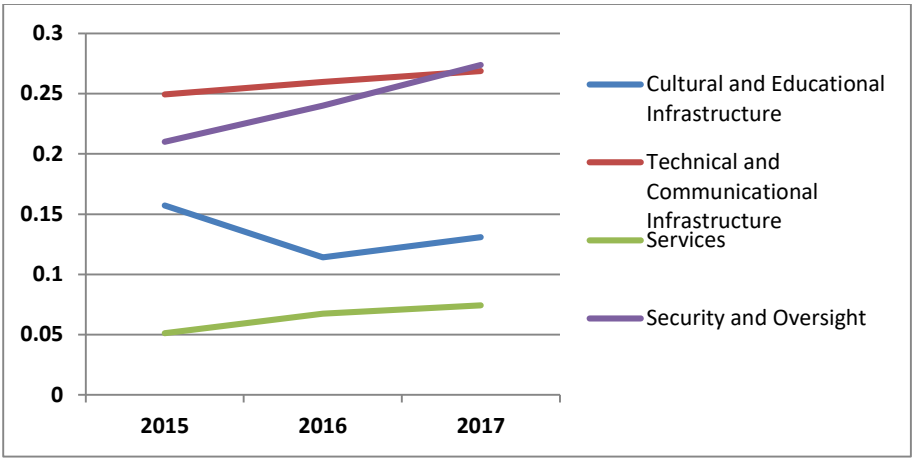

Figure 3. Comparison of the growth trend of e-banking dimensions at Keshavarzi Bank from 2015 to 2017.
Source: Research Findings

Overall e-banking index of the Keshavarzi Bank, shown in Figure 4, has been growing for three years, but its growth trend in 2017 has accelerated.

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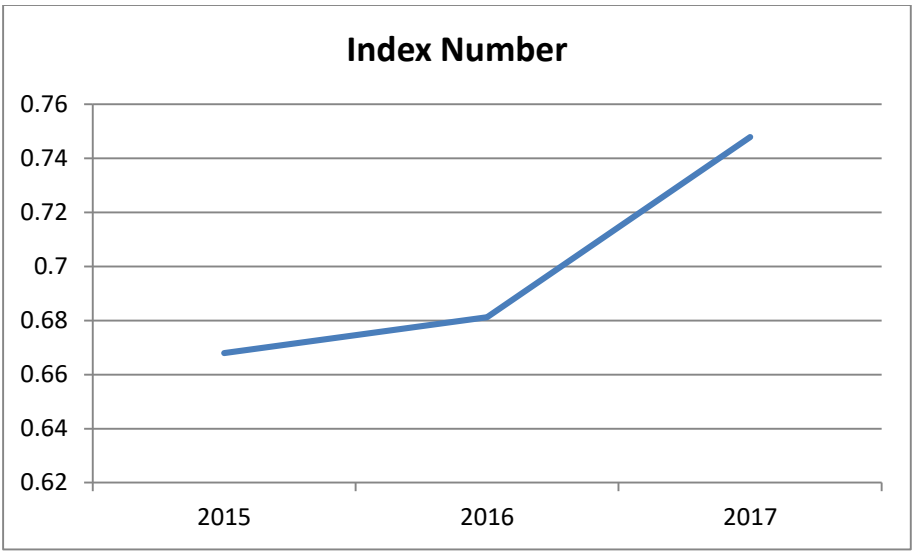

Figure 4. Comparison of the growth trend of E-Banking Progress Index at Keshavarzi Bank during 2015 to 2017.
Source: Research Findings

4 Conclusion and Summary

Since the presentation of the World Bank report in 2008, an index that can cover all aspects of e-banking has not been presented. In this study, we have tried to fill this scientific gap. After studying the 2008 World Bank's report on measuring the development of payment and research systems that have been followed up around the world in this area, we have introduced the E-Banking Progress Index. Comparing E-BPI with the World Bank's report, we can mention the following differences:

1) The World Bank's report investigates the dimensions individually while combining the dimensions; E-BPI compares criteria and dimensions interacting with each other.
2) The World Bank's report does not analyze the countries' status and just classifies them independently. On the other hand, E-BPI can analyze the strengths and weaknesses of an e-banking system.
3) The World Bank's report just takes the classification to the national level among countries, but E-BPI also provides a comparison in the firm (bank) level.

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In this study, we have first classified e-banking with World Bank's Method and conducted interviews with the macro and middle managers of the Iranian e-banking sector. Next, by designing a paired comparison questionnaire and distributing it among managers and senior experts in Iranian e-banking and using Analytical Hierarchy Process, we have identified the final important coefficients. Finally, we continued with scoring the components using mathematical methods in order to introduce a combinational index to measure the progress of e-banking at the level of banks or countries.

E-BPI has been introduced to integrate all aspects of e-banking. It makes a path in front of organizations, regulatory bodies, and decision-makers to help them to improve and progress an e-banking system by investigating the performance of its various parts. This research aims to introduce a new way to do studies in this field with a comprehensive point of view on e-banking.

4.1 Results of Study

4.1.1 Results at National Level

At this level, e-banking contains five dimensions, among which "Technical and Communicational Infrastructure" has the highest importance, and "Services" has the lowest importance. Figure 5 shows the weight comparison of five different dimensions of this index:

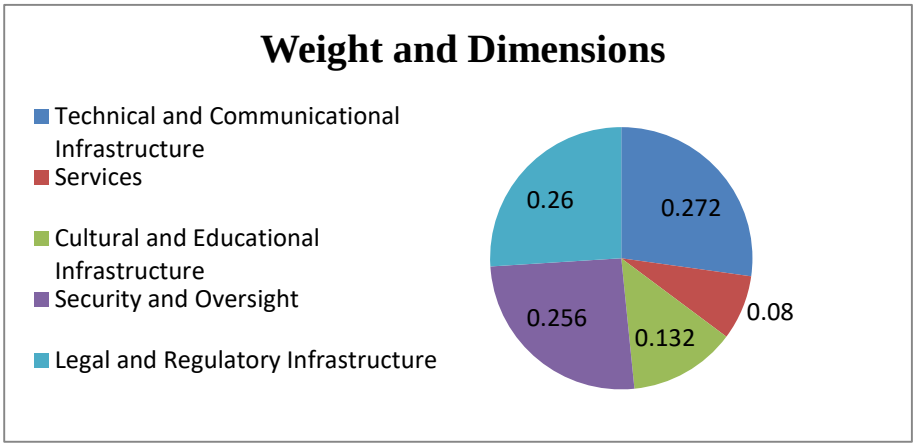

Figure 5. Weight Comparison Pie chart of Five Dimensions of E-BPI.
Source: Research Findings

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At National Level, the index may be of interest to the Ministry of Economic Affairs and Finance, Ministry of Information Technology, and Central Bank to apply it in order to develop an e-banking section, identify the obstacles to this development, and help its growth with appropriate investments.

4.1.2 Results at Bank-Level

This case has four dimensions, among which "Security and Oversight" has the highest importance and "Services" has the lowest importance. Figure 6 shows the weight comparison of four different dimensions of this index:

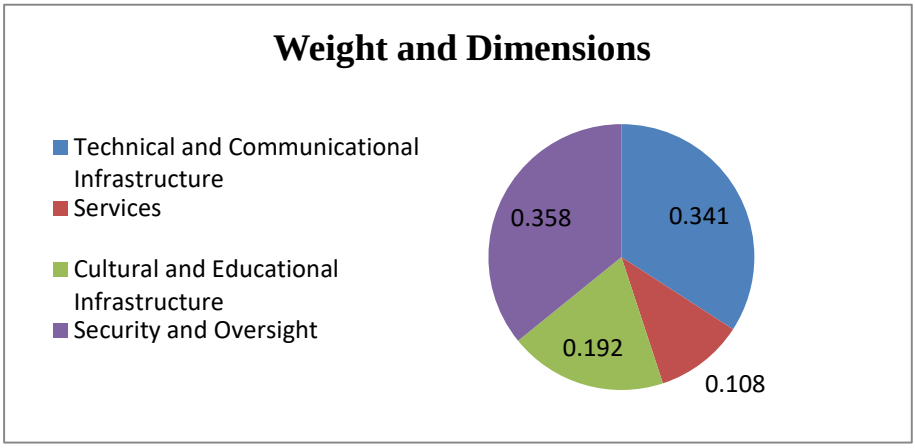

Figure 6. Weight Comparison Pie chart of Four Dimensions of E-BPI.
Source: Research Findings

4.2 Summary

E-banking, which is one of the most important banking sectors, can move forward along with technology macro trends by the right investments and new digital technologies. It can reduce banking costs and can increase efficiency. For example, suppose a bank receives a low score in the tools section but claims to have incurred significant costs for the sector. In that case, it should reconsider its approach to the electronic tools and invest more properly in this section. And in this way, it may be able to expand the adoption of its electronic tools at a lower cost. The development of the informatics industry has caused major changes in service systems and the form of money in the banking field. This development has created new phenomena such as home banking, telephone banking, remote banking, Internet banking, ATMs, sales terminals, branch terminals, virtual banking, and online branches through the emergence

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and the development of e-banking. This diversity of banking tools and services leads to difficulties in identifying an appropriate e-banking system, so using a combinational index introduced in this paper can end the confusion created in this area and help promote an e-banking system.

This study has paid special attention to the digital knowledge and technologies applied in e-banking by focusing on its infrastructures and tools. We have also considered improving employees' information level and customer training in optimum use of this technology in the calculations.

This paper introduces E-BPI and describes how to compute it (in section 3.2). Generally, by using the data in an e-banking system, E-BPI can measure the system's progress and identify its strengths and weaknesses. In order to show the efficiency and applicability of E-BPI, we provide a case study (section 3.5.) that shows how we can compute the index numerically and the results we can infer from it.

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