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Risk Assessment Strategies in Credit Process of Iranian Banking System Case study: Banks listed in Tehran Stock Exchange

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Abstract

Purpose and theoretical framework: This applied-descriptive research has been performed to the aim of identifying fraud risk assessment strategies in credit process of Iranian banking system. Statistical population of the research includes banks listed in Tehran Stock exchange.

Design and methodology: To collect data, library and field studies have been used through distribution of questionnaire among participants i.e. university experts, as well as experts in the banking field and risk management. To analyze data, descriptive and inferential statistical tests such as factor analysis and structural equation modeling (SEM) have been used.

Findings: In general, the research findings show that fraud risk assessment strategies in credit process have considerable effect on performance of operational risk management in credit process of Iranian banking system. Therefore, the results have been indicating that fraud risk assessment strategies in credit process of Iranian banking system have to be taken into consideration by economic activists, investors, government, and supervising institutions.

Implications: Therefore, with consideration of the results from present research it is proposed that in credit field of banks, more attention would be paid to the issue of various types of fraud risks; and, future researchers are suggested to study the role played by internal control and corporate governance on operational risk management in credit process of banks listed in Tehran Stock Exchange, and to compare their results with those of present research for analysis. It goes without saying that, most important restrictions existing in this research and considered in interpretation of results include: low number of researches with similar subject, including those performed inside the country and out of it due to novelty of the subject.

Keywords: stock trading strategy; minor factors; major factors; Markov-switching model.

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1. Introduction

The most important functions of financial system in every economy are making access to liquidity, allocation of resources, and risk management; and, the role played by them considerably affects economic stability or crisis (Mohaghegh Nia et al., 2019:127). In fact, existence of an advanced financial system provides the country with a basis for financial and economic development. This in turn is dependent on performance of decision makers in financial system; because, their decisions made by contributors in financial system are important are important for achievement of financial development goal. Financial decisions made by contributors in an integrated financial system are based on financial supply and demand; and, it considerably affects volume of financial resources and consumptions. So, appropriate patterns of financial decision making lead to improvement of performance in financial markets of the countries, increasing contribution share of people, and other desirable phenomena at micro and macro levels (Eslami Mofidabadi et al., 2018:1). In this respect, one of the required and effective tools for economic development of the country is existence of an efficient banking system. Banks are considered stimulator for financial activities and how they are governed is highly effective on other economic sectors of a society. Organizing and directing payments and receipts, banks facilitate commercial transactions and lead to expansion of markets, as well as economic growth and boom. However, during recent years, banking industry has been facing numerous challenges due to various reasons including the risk resulted from fluctuations in interest rate, inflation, currency rate, and or lack of repayment of loans. Continuity and severity of these challenges for banking industry in the world has caused many social crises in the countries. These outcomes have made persons in charge of supervision and executive institutions in financial systems to consider risk management in financial institutions especially banks, with more expertise and enthusiasm (Shayan Arani, 2001). In addition to the above roles and with consideration of main activity of banks being collection of cash and granting loans; studying effective factors on credit risk is of special importance to reduce amounts of deferred claims (Mohaghegh Nia et al., 2019:127). The reason is that, banks and financial institutions will become clearly risk taking due to performance of different business activities like investment, funding in enterprises, and/pr granting loans; and, the procedure affects repayment of main amount of the loan and the interest. However, one of the relatively new methods of reducing credit risk followed by reduction of banking claims is application of operational risk principles and processes formulated by Basel Committee on Banking Supervision (BCBS) so that credit risk in credit process of banking system would be managed.

It goes without saying that, from among various banking risk, credit risk is the oldest and biggest risk in banking business. That is, most of banking risk management literatures is allocated to the field of credit risk (Arunkumar, Rekha and Kotreshwar, 2006).

However, during recent years and due to structural weakness and lack of accurate, in time, and understandable reports, operational risk in credit process of banking system has turned to a subject to be taken into consideration in banking risk-related literature. That is, accordingly concept of accounting risks nowadays has turned to one of the most outstanding subjects in all around the world (Wahlstr, 2006: 494) to the extent that BCBS also have provided a comprehensive definition about operational risk as follows: “operational risk is probability of losses resulted from inappropriateness and lack of adequacy of processes and methods, people, and internal systems, or resulted from events occurring outside credit institution” (BCBS, 2001; Islamic Republic of Iran Central Bank’s Guidance, provision No. 1172MB dated June 21st, 2007; Office of Banking Studies and Regulations). In this respect, a very important point in relation to operational risk management in credit system can be referred to i.e. fraud risk in credit process of banking system. The subject has been and will be always discussed in banking system; because, existence of fraud by itself and as one of the criteria

for identification of operational risk in credit process of banking system has considerable effect on performance of credit risk management in banks. Of course, to identify those factors preventing occurrence or reducing effectiveness of the risk caused by fraud in credit process of banking system; different tools, methods, and institutions have to be defined so that based on them risks especially operational risk in credit process of banking system would be managed.

Therefore, in the research effort has been made for effective factors on occurrence of fraud risk in credit process of Iranian banking system to be identified; and, effectiveness level of each of them on operational risk of credit risk of Iranian banking system to be specified. To do so, using exploratory analysis, factor analysis and SEM; effectiveness of different fraud risk assessment strategies and their level in credit process on performance of credit risk management in Iranian banking system has been identified.

2. Literature Review

2.1. Research Empirical Literature Review

Various studies have been performed in relation to operational risks and performance of banking risk management, some of which related to the subject of present research would be referred to in table (1).

Table 1: Summarized introduction of research background

Researcher	Year	Title	Result
Wang et al.	2019	Fraud detection strategies as for credit cards through tendencies of consumer	Conditions under which the strategy is attractive for traders have been identified and shown that probability of "win-win" result for consumers, traders, and credit card issuer exists when tolerance of consumer against fraud would be reduced and incentive value would be within certain limit. Moreover, it was shown that decisions made upon coordination of traders and card issuer can create other advantages. Finally, effectiveness of different proposed strategies has been provided through real credit card data.
Patil et al.	2017	Predictive modeling for fraud detection in credit card through data analysis	It was suggested by them that financial and banking affairs in today's generation is an important sector that makes every person would be required to contact banks either in person or online. In the paper, they have discussed an analytical framework of Big Data for processing high volume of data, as well as execution of different machine learning algorithms to detect concerned frauds; and, their performance has been observed in the set of standard data so that real time frauds there could be detected with low risk and high customer satisfaction.

Ikret and Getzert	2017	Operational risk through consideration of credit risk / a comprehensive analysis for financial companies	In review of credit risk through 3 different models 1- simple deterministic model; 2- random model through distributive hypotheses; and, 3- developing second model through consideration of company's capability, it was concluded by them that credit losses can be much more expanded than operating losses in the field. Also, ignoring credit risks would be resulted in underestimating various operating risk especially fraud risk.
Urbina and Glain	2014	Using capital allocation principles in respect of operational risk and fraud cost	Here, several principles from those related to capital allocation have been studied so that it would be shown that how these principles can be used for distribution of obtained capital among different components leading to operational risks. For example, proper allocation is capable of calculating a unit cost. As a result, an applied example for fraud risk in banking sector and correlation scenarios between commercial lines have been also comparatively provided for them.
Mohaghegh Nia et al.	2019	Effect of internal and external factors of banking industry on credit risks of banks in Iran	From among bank's internal variables, size, and capital have positive effect, and increase of loan granted has negative effect on credit risk; and, from among bank's external variables, centralization, liquidity growth rate, and currency price rate growth have positive effect and development of banking sector and economic growth rate have negative effect on credit risk.
Saghafi et al.	2017	Comprehensive pattern of credit risk management in Iranian Banking system	Using research strategy of grounded theory, and passing through different coding stages; they have achieved a three-section framework for comprehensive pattern of credit risk management, including policy, methodology, and infrastructure.
Yazdani et al.	2016	Identification of operational risks in Islamic contracts and provision of some mechanisms for its management in Ansar Bank	In the results obtained through FMEA method, it became clear that operational risks of Islamic contracts and banking contracts are divided into four general categories of "risk tolerance", "risk reduction", "non-acceptance of risk", and "critical status of immediate action. Also, coping methods as well as control measures for each of these categories have been introduced so that operational risks could be finally reduced to acceptable level by banks.

2.2. Research Theoretical Literature

Credit Risk

The most important risks a head of banking system are credit risk, market risk, operational risk, legal risk, adequacy risk of capital, rate of return risk, money or currency risk, and liquidity risk. Anyway, risk as a threat affects banks' activities and credit risk is of twice importance; because, it is resulted from the most important banking operation i.e. granting loans. However, one of the most important effective factors on health of banking system is credit risk (Baral, 2005). Credit risk is defined by Basel Committee on Banking Supervision as: failure of the borrower to satisfy his obligations for payment of loan under agreed condition (BCBS, 2000). In other words, probability

for lack of return of principal amount of loan granted and its interest is called credit risk (Kohzadi, 2003). In another definition, credit risk is the risk is created when the other party fails to comply with his obligations (Akhtari, 2010). Finally, it could be suggested that the risk related to the losses resulted from repayment of loans or delayed repayment of principal amount of loan and its interest by customer is called credit risk (Nikpay, 2006). This level of risk depends of quality of bank's assets; and, quality of bank's assets also depends on procedure of noncurrent claims, as well as health and profitability of borrowers. In fact, credit risk in a bank may be resulted from bankruptcy and its customer not being capable of repayment of principal amount of loans and its interest. The risk means that bank resources are not returned by debtors including credit customers (Ekhtiari, 2010).

Risk management in banking system credit process

Credit risk has been always main concern of institutions providing financial services; however, the risk has not been effectively managed. Financial crisis in 2007 resulted in more weakness of risk management systems. After the crisis in 2007, it was found by banks, insurance companies, and investment companies that conventional credit risk management methods are useful and important; however, they might not be enough. In addition to conventional methods used by these institutions, they are looking for adaptation and creation of innovative methods for credit risk management. Because of credit risk dependence on other risks available, these companies are looking for an integrated credit risk management system. Some of credit risk management methods are as follows (Agarwa, 2011).

Credit Portfolio Model

Many of financial institutions have their own internal credit model used for credit risk management. Credit portfolio model includes credit risks of various activities resulted from different factors such as industry, geography, and credit level; and, through numerical simulation, different modes are created for countries with different economies and effect of such selection on credit portfolio would be stated by them. This analysis helps managers in their decision making to select what combination of this credit portfolio, with consideration of their performance and objective (Mohaghegh Nia et al., 2019:127).

Internal Ranking

In general, it is a reflection of financial institution's capability for payment of debt. In addition to ranking standard specified by credit rating agencies, companies use their own internal rating system for computation. Each institution may have its own unique credit rating method (Mohaghegh Nia et al., 2019:127).

Stress Test

Stress test includes different techniques used by financial institutions to measure vulnerability level when probable but exceptional phenomena happen (Rahnamaye Roodposhti; Allahyari, 2015). Stress test currently is considered as a supervision requirement for some countries so that maintenance of adequate level of capital by them would be assured (Mohaghegh Nia et al., 2019:127).

Conceptual Research Model

In continuation and based on literature review, conceptual model of research will be provided through figure (1):

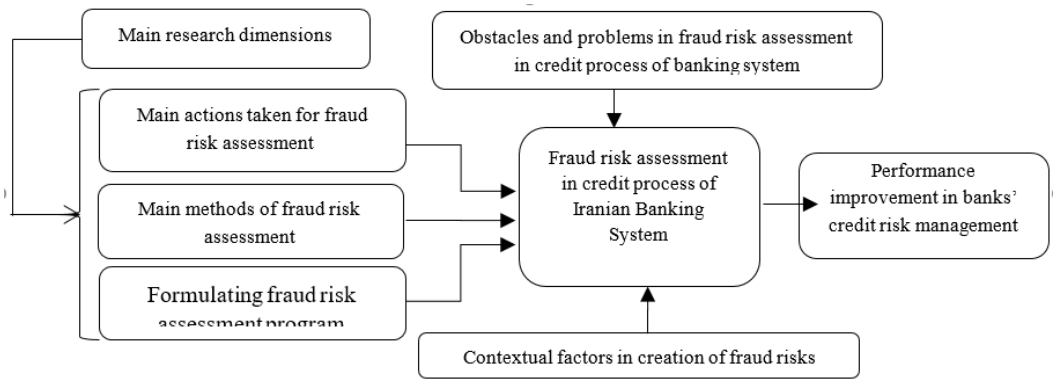

Figure 1: Research conceptual model

3. Research Methodology

The research has been performed to the aim of studying fraud risk assessment strategies in credit process of banking system in Iran and providing management strategies for them. So, the research is of applied nature. Considering research question being focused, the researcher had to make decision whether to perform exploratory or descriptive research, and/or hypothesis test (Tharenou et al., 2007)? In present research, the author has primarily prepared research plan to collect and study research literature based on related subject. After studying theoretical foundations, components and hypotheses' variables have been identified. Both library and field data collection methods have been used in the research. Required studies about research theoretical foundations, thematic literature, problem records, and subject of the research have been performed through library methods and review of resources, university theses, and related researches, as well as using websites. Meanwhile, for main stages of the research and data collection, field study including researcher-made questionnaire has been used. Statistical population of the research includes risk managers and experts in Iranian Banking System, as well as university professors and experts in risk-related issues. Due to large (infinite) statistical population, 384 persons therefrom have been selected as groups through Krejcie and Morgan method. To analyze data, statistical tests (descriptive and inferential), factor analysis (exploratory and confirmatory), and multiple regression have been used.

4. Research Findings

In the research and to analyze data as the most important part of present research, important data have been collected. Then, raw data have been analyzed through statistical software. After processing, data would be available to users in form of information. That is, in this section, primarily factor analysis has been performed and then, main research model has been studied. Finally, research hypothesis has been tested. To study and analyze research questions, SEM method has been used via Smart-PLS software. The method provides the possibility of correctness of test would be tested and significance level of obtained coefficients would be shown.

Table 2: Introducing Statistical Sample Characteristics of Research

No	Describe the characteristics of the statistical population of the study	Determining the proportion of the statistical population	Statistical sample according to Krejcie and Morgan method	Selection of the final statistical sample
1	Financial Management and Accounting Students and Graduates (current trends)	80 %	384	30.72
2	Risk managers of Iranian banks and financial institutions	12 %	384	46.08
3	Professors and academic experts in the field of risk management	20 %	384	76.80
4	Banking experts in Iran	60 %	384	230.04
5	Statistical population of the study	100 %	***	384

As observed in above table, due to large (infinite) statistical population, statistical sample has been specified according to Krejcie and Morgan Table (1970). Of course, to collect questionnaire data, measurable items in terms of fraud risk in credit process of Iranian Banking System (Table 3) have been primarily identified based on theoretical foundations studied and operational structure of credit process, as well as interviews with banking experts, observation of documents and real events in credit sector of Iranian Banking System's credit sector.

Table 3: Fraud and Fraud Risks Identified in the Credit Process of Iranian Banking Industry

Sub component	Description	Intensity of the effect	Probability 0f occurrence	Probability of discovery	Risk Matrix	Level of risk	RPN score
	Failure to monitor the use of facilities in the relevant channel	4	2	3	8	Risk reduction	24
	Fake trade information	3	2	3	6	Risk tolerance	18
	Failure to include facilities in the Statute	2	2	3	4	Risk reduction	12

Risk of inadequate oversight in the credit process	Facilities approved outside the branch	3	2	3	6	Risk tolerance	18
	Incom-patibility of the appraised amount with the property in question	3	3	3	9	Risk reduction	27
	Mortgage without the presence of a bank representative	3	2	3	6	Risk tolerance	18
	Failure to obtain registration request for facilities exceeding one billion riyals	2	2	3	4	Risk reduction	12
	Increase unrealistic resources when repaying the facility	3	2	3	6	Risk tolerance	18
Risk of Bank Credit Sector Preventive Measures Properly Implemented	Failure to comply with the advance notice as per the notice available	3	2	3	6	Risk tolerance	18
	Refusal to include facilities or property in the Statute	2	2	3	4	Risk reduction	12
	Error in registering the contents of the regulatory letter to the office	4	2	3	8	Risk reduction	24
	Revocation of customer credit code despite having live facilities	3	2	3	6	Risk tolerance	18
	Payment facilities on time or not informing the customer in order to falsely increase the resources of the branches	4	2	3	8	Risk reduction	24
Risk of neglecting and collecting incomplete customer information	Deliberate negligence in installment payments in order to enter into the heading of receipts and	3	2	3	6	Risk tolerance	18
	The probability of not receiving a certificate of inquiry from guilds and being fake class information	3	2	3	6	Risk tolerance	18
	Possibility of customer fraud in preinvoice and stamp check facilities	4	2	3	8	Risk reduction	24
	Filing a facility file for a customer who does not have the appropriate creditworthiness and capacity	4	2	3	8	Risk reduction	24
	Fake financial statements	4	2	3	8	Risk reduction	24
	Fake certificate of deduction	4	4	3	16	Risk reduction	48
	Receipt of Certificate of Approval Certificate of deduction by telephones provided by customer or inserted in certificate	4	2	3	8	Risk reduction	24
	Incompatibility of the header of the relevant organ with the seal and signature of the certificate of deduction	3	2	3	6	Risk tolerance	18
	Not paying attention to the possibility of forgery (guarantees)	4	4	3	16	Risk reduction	48
	Failure to find original documents provided and the possibility of counterfeiting copies of identity documents	3	4	3	12	Risk reduction	36

	Failure to issue a certificate of deduction by the Finance	3	4	3	12	Risk reduction	36
	Not taking into account the results of inquiries in the granting of facilities	4	2	3	8	Risk reduction	24
	The absence of a credit approval database	4	4	3	16	Risk reduction	48
	Lack of sufficient time to confirm the certificate of deduction	3	2	3	6	Risk tolerance	18
	Contrary to the applicant's requested collateral and the collateral recorded in the decree	4	4	3	16	Risk reduction	48

As observed in table (3), in the research and based on theoretical foundations and operational structure of credit process, as well as interviews with banking experts, observation of documents, and real events in banking environment; 28 items have been identified as fraud risk dimensions in credit process of Iranian Banking System.

Table 4: Introducing Measures, Methods, Strategic Plan and Performance in Relation to Operational Risks of Iranian Banking Industry Credit Process

Description	Main and sub perspectives		Source
Actions	Measures of Credit Risk Management Policies at Large Level	Credit risk assessment in small size banks	Horstand and Linjama (2015)
		The existence of different credit risk management practices in the banking system	Anbar (2005),
		A framework for evaluating risk management practices in an organization	Basil Erichen (2002),
		Requires active credit risk management	Stales (1984), Smith, Smithson & Walford (1990), Frout, Sharfstein & Stein (1993),
		Types of Banking Risk Management Strategies	Griening and Brajavik (2009),
	Micro risk management policy measures	Schejualed plan	Wang et al., 2019
		Data quality	
		Sharing mechanism	
		Predictability of model results	
		High mortality rate	
		Neural network	(Atia, 2001),
		Genetic Algorithm	(Chen and Hang, 2003)
		Combining audit analysis and neural network	(Yu, 2008),
		Data covering analysis	(Email, 2003; Minh & Lee, 2008)
		Combined methods of backup vector machine decision tree	(Yu, 2010)

Methods	Credit risk	Combining decision tree and neural network	(Yanping, 2012)
		Logistic regression	(Kabari Venovachkova, 2013)
		Artificial bee colony-based neural network	(Pusa, 2016)
		Application of Survival	(Fallahpour, Raei and Hendijani Zadeh, 2013)
		Analysis Theory	(Korani and Aghaipur, 2014)
		Split Tree and Regression	(Mirghofuri, 2015)
Strategic Plan	Develop a credit risk assessment strategy	Continuity of work operations management	(Circular No: Mob / 3244, Date: 3/8/2008, Department of Banking Studies and Regulations of the Islamic Republic of Iran's Bank of Iran, 2007), (Field Inspection and Review, 1977).
		Compiling a written and comprehensive plan of affairs	
		Credit Institution Operations recovery	
		Compilation of an overview of the goals, attitudes and operational orientation of the credit institution	
		Long-term plan development (for a period of 3 to 5 years)	
Function	Credit risk management plan development perspective		Examples include Ebay et al. (2012), Hailey et al. (2012), Nawaz & Munir (2012), Abdul Rahim (2013), Idu and Ayumi (2014), Ogboi and Onafe (2013), Korawa & Garba (2014), Lee & Zoo (2014), Khosh Yima & Shahiki Tash (2012)

As observed in the above table, in the research credit risk management policies and measures have been taken into consideration in terms of credit risk assessment method and credit risk management performance in Iranian Banking System.

Table 5: Introducing Barriers and Problems for Operational Risk Assessment of the Banking Credit Process

Description	Main and sub perspectives	Source
Structural	Social and cultural	(Fieldwork and Field View, 1977)
	Weaknesses of software and hardware systems	(Shirvani, 2004)
	Weak management	(Shirvani, 2004)
Jurisprudence and legal problems	Lack of awareness and training on Islamic banking issues	(Shirvani, 2004)

Ownership structure	Beware of lending behavior of state-owned banks	(Sapinza, 2004), (Kordebche and Nooshabad, 2011)
	Managerial ownership and risk taking behavior	(Chun et al., 2011)
	Concentration of ownership and risk taking behavior	(Siri, 2013), (Black, 2010)

In table (5), a summary of obstacles and problems in assessment of operational risks in credit process has been provided in three structural, jurisprudence and legal categories.

Table 6: Introducing the underlying factors of the banking system's credit risk operational process

Description	Main and sub perspectives			Source
Inner	Corporate Governance Mechanisms and Bank Risk Behavior	Internal	Board siz	(Masoumi, 2014) , (Mahmoud Abadi & Zamani, 2016), Homayoun & Yarahmadi, 2017) ,(Farzan, 2017)
			Independence of the board	
			Duality of the role of director	
			Property management	
			Centralized ownership	
			Non-Executive Board Members	
			Board Bonus	Hamidian, 2016)
			CEO Separation of Members	
			Government Board Stocks	(Demsaz & Len, 1985), (Hamidian, 2017)
		External	Percentage of free float stock	(Hamidian, 2016)
			Percentage of institutional shareholder ownership	
			and government influence in corporations	
Exterior	Monetary and Financial Stability Frameworks and Approaches to Financial Markets		Integrated and twin surveillance model	(UK Financial Policy Committee, 2006/2015)
			Integrated monitoring model	(German Financial Stability Commission, 2006/2015)
			Functional (with some double peak structures)	(French Financial Stability Council, 2006/2015)
			A couple of peaks	(US Financial Stability Monitoring Council, 2006-2015)
			Integrated	Not defined (Bank of Japan's cooperation with the Ministry of Finance, 2006/2015)

In table (6), a summary of contextual factors in creation of operational risks in credit process of banking system is presented. Therefore, in the research and based on studying theoretical foundations and empirical research literature, contextual factors in creation of operational risks in credit process of Iranian Banking System are divided into two internal and external factors. That is, among internal bank factors, corporate governance, risk, and risk taking behavior of banks have been the most important factors; and, among external bank factors, monetary and financial stability approaches and frameworks in financial markets and risk taking behavior of banks have been specified as the most important factors.

Statistical description indices and drawing frequency distribution table of observations:

Table 7: Statistical Description of the Components Identified in Operational Risk Management

Descriptive statistics		Describe the components of important measures to manage operational risk						
		TR_1	$HRMR_1$	ITR_1	SSR_1	FR_1	B_1	RR_1
Number	Correct	384	384	384	384	384	384	384
	False	0	0	0	0	0	0	0
Average		3.6348	3.6271	3.6237	3.6159	3.6493	2.9167	3.6354
Middle		4.0000	4.0000	4.0000	3.8333	4.0000	3.0000	4.0000
View		4.00	4.00	4.00	4.00	4.00	2.00	4.00
Total		1395.75	1392.80	1391.50	1388.50	1401.33	1120.00	1396.00
Descriptive statistics		Component descriptions of important approaches to operational risk management						
		TR_2	RR_2	$HRMR_2$	SR_2	ITR_2	SSR_2	FR_2
Number	Correct	384	384	384	384	384	384	384
	False	0	0	0	0	0	0	0
Average		3.5612	3.5638	3.8146	3.8333	3.8314	3.9288	3.8559
Middle		3.7500	3.7500	4.0000	4.0000	4.0000	4.0000	4.0000
View		4.00	4.00	4.00	4.00	4.00	4.00	4.00
Total		1367.50	1368.50	1464.80	1472.00	1471.25	1508.67	1480.67
Descriptive statistics		Describe the components of an important strategic plan for operational risk management						
		TR_3	RR_3	$HRMR_3$	SR_3	ITR3	SSR_3	FR_3
Number	Correct	384	384	384	384	384	384	384
	False	0	0	0	0	0	0	0
Average		2.8652	2.8672	2.8734	2.8659	2.8646	2.8624	2.8689
Middle		3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000
View		3.00	3.00	3.00	3.00	3.00	3.00	3.00
Total		1100.25	1101.00	1103.40	1100.50	1100.00	1099.17	1101.67
Descriptive statistics		Description of the Identification and Assessment of Fraud and Fraud Risk (FR) Component of the Credit System of the Iranian Banking System						
		TR4	RR4	HRMR4	SR4	ITR4	SSR4	FR4
Number	Correct	384	384	384	384	384	384	384
	False	0	0	0	0	0	0	0
Average		3.7917	3.7884	3.7755	3.7897	3.7878	3.8016	3.7587
Middle		4.0000	4.0000	4.0000	4.0000	4.0000	4.0000	4.0000
View		4.00	4.00	4.00	4.00	4.00	4.00	4.00

Total	1456.00	1454.75	1449.80	1455.25	1454.50	1459.83	1443.33

Source: research findings (researcher's calculations).

Descriptive statistics		Descriptions of Components Identifying the Barriers and Problems of Operational Risk Assessment of the Banking Credit Process		
		B1	B2	B3
Number	Correct	384	384	384
	False	0	0	0
Average		2.9167	2.8828	2.9193
Middle		3.0000	3.0000	3.0000
View		2.00	2.00	2.00
Total		1120.00	1107.00	1121.00
Descriptive statistics		Describe the components of the underlying factors that create operational risks to the credit system of the banking system		
		GOR1	GOR2	GOR3
Number	Correct	384	384	384
	False	0	0	0
Average		3.5612	3.2812	3.4062
Middle		3.7500	3.0000	4.0000
View		4.00	4.00	4.00
Total		1367.50	1260.00	1308.00
Descriptive statistics		Descriptions of Components of Banking Credit Risk Manager Performance Improvement Factors		
		IPB1	IPB2	IPB3
Number	Correct	384	384	384
	False	0	0	0
Average		3.0000	3.0000	3.0000
Middle		3.00	4.00	4.00
View		1100.25	1222.00	1223.00

Source: research findings (researcher's calculations).

4.1. Exploratory Factor Analysis

Before factor analysis, data have to be reviewed. Table (8) shows the results from KMO and Bartlette tests. Considering the table and as far as KMO (Kaiser-Meyer-Olkin) value is equal to 0.786 and bigger than 0.7; data are appropriate for performance of factor analysis. Also, with consideration of significance value equal to zero and being smaller than 0.05; Bartlette test results are significant. That is, significant correlation exists between variables and they can be studied through factor analysis.

Table 8: KMO test results and Bartlett

KMO test		0.795
Bartlett's Spear Test	Xi statistic	4.007 E4
	Degrees of freedom	666
	p-value	0.000

Source: Researcher Findings (Researcher Field Surveys).

Considering KMO value (bigger than 0.7), and significance value of Bartlette test (Sig<0.05); it can be suggested that data are appropriate for factor analysis and satisfy required conditions.

Table 9: Cronbach's alpha coefficient results and composite reliability of research hidden variables

No	Descriptions of Experimental Research Model Statements		Cronbach's alpha coefficient (Alpha> 0.7)	Combined reliability coefficient (CR> 0.7)
	Farsi define the symbol of the Maknon variables	Define the symbol of the Maknon variables		
1	Important Actions to Manage Operational Risk (Acts)	AC	0.996414	0.996940
2	The Barriers and Problems of Operational Risk Assessment of the Banking Credit Process	B&Ps	0.971550	0.981329
3	Background to the Operational Risks of the Banking Credit Process	GORCSPBS	0.887105	0.927372
4	Identify and evaluate the types of operational risks in the credit system of the Iranian banking system	I&ATORCS	0.982396	0.986054
5	Improving banks' credit risk management performance	IPBCM	0.930517	0.955706
6	The main dimensions	MDs	0.922663	0.929634
7	Important Methods for Operational Risk Management (Methods)	ME	0.962617	0.969658
8	Important Strategic Risk Management Program (SPs)	SP	0.997055	0.997485

Considering proper value for Cronbach's alpha and composite reliability being equal to 0.7 and consistent with the findings from the above table, these criteria about latent variables have adopted appropriate value; and, reliability of the research can be confirmed.

Table 10: Initial Subscriptions

No	Description of the main points of the empirical research model	Descriptions of Experimental Research Model Statements		Initial	Extraction
		Farsi definition	Definition Symbol		
1	Different aspects of fraud and fraud (FR)	The risk of inadequate oversight in the credit process	FR1	1.000	.960
		Risk of Proper Implementation of Bank Credit Sector Preventive Measures	FR2	1.000	.959

		Risk of neglecting and collecting incomplete customer information	FR3	1.000	.970
		The risk of inadequate oversight in the credit process	FR4	1.000	.940
2	Barriers and Problems of Operational Risk Assessment of the Banking Credit System (B & Ps) Process	Structural	B1&Ps1	1.000	.934
		Jurisprudence and legal problems	B2&Ps1	1.000	.926
		Ownership structure	B3&Ps1	1.000	.972
3	Background to the Operational Risks of Banking System Credit Process (GORCSPBS)	Inter-banking (Corporate Governance Mechanisms and Bank Risk Behavior)	GOR1	1.000	.867
		External Banking (Monetary and Financial) Stability Frameworks and Approaches to Financial Markets	GOR2	1.000	.688
		Adverse events (small, medium and large)	GOR3	1.000	.830
4	Bank Credit Risk Management Performance Improvement Indicators (IPBCM)	Comprehensive policy and policies	IPBCM1	1.000	.738
		Proper infrastructure	IPBCM2	1.000	.759
		Appropriate methods and techniques	IPBCM3	1.000	.895

The table has two columns titled Initial and Extraction showing communality of a variable (item) being equal to square of the multiple correlations (R^2) with factors. First column shows initial communalities (intersections before extraction of factor or factors); and, all initial communalities are equal to one. The bigger would be value of extracted intersection (bigger than 0.5), the better would be described (represented) the concerned factors. So, in the above table appropriateness of all questions in process of factor analysis process are shown; because, value of questions' communalities is higher than 0.05. Table of total variance explained shows that these questions constitute eight factors and these factors explain and cover about 92.693% of variances which in fact shows validity of questions. In continuation, rotated factor matrix would be presented. Correlation of Items (questions or variables) and the factor would be specified by the matrix which will become clear based on correlation level of the relationship. In the matrix, factor loadings (factor scores) of each of variables are bigger than 0.5; and, they are covered by concerned factor. The more would be value of this coefficient; the stronger role would be played by concerned factor in total changes (variance) in concerned variable. In the following table, it is shown that which questions and with what factor loadings are related to these factors?

Table 11: The rotating factor matrix

No	Description of the main points of the empirical research model	Descriptions of Experimental Research Model Statements		Component						
		Farsi definition	Definition Symbol	1	2	3	4	5	6	7
1	Different aspects of fraud and fraud (FR)	The risk of inadequate oversight in the credit process	**FR1**	.113	.957	.137	.044	.104	.025	-.005
		Risk of Proper Implementation of Bank Credit Sector Preventive Measures	**FR2**	-.040	.080	.116	.967	.018	-.021	-.029
		Risk of neglecting and collecting incomplete customer information	**FR3**	.977	.109	-.010	-.006	.044	.047	.017
		The risk of inadequate oversight in the credit process	**FR4**	.014	.159	.947	.079	.063	-.079	-.034
2	Barriers and Problems of Operational Risk Assessment of the Banking Credit System (B & Ps) Process	Structural	**B1&Ps1**	.087	.060	-.107	-.009	.095	.950	.003
		Jurisprudence and legal problems	**B2&Ps1**	.077	.001	-.128	-.018	.072	.945	.072
		Ownership structure	**B3&Ps1**	.085	.039	-.126	-.006	.117	.966	.023

3	Background to the Operational Risks of Banking System Credit Process (GORCSPBS)	Inter-banking (Corporate Governance Mechanisms and Bank Risk Behavior)	**GOR1**	-.087	.084	.111	.101	.894	.074	-.161
		External Banking (Monetary and Financial) Stability Frameworks and Approaches to Financial Markets	**GOR2**	.196	.094	.235	.093	.733	.165	-.113
		Adverse events (small, medium and large)	**GOR3**	.164	.168	.036	.251	.808	.033	-.238
4	Bank Credit Risk Management Performance Improvement Indicators (IPBCM)	Comprehensive policy and policies	**IPBCM1**	.015	.111	.105	.067	.225	.024	.811
		Proper infrastructure	**IPBCM2**	.017	.083	.167	-.005	.227	.034	.819
		Appropriate methods and techniques	IPBCM3	.019	.141	.165	.030	.200	.042	.897

4.2. Convergent Validity

Second criterion resulted from studying fit of measurement models is convergent validity that deals with correlation level between each structure and its own questions (indicators). Convergent validity exists when scores obtained from two tools about one concept are of high correlation with each other. That is, convergent validity means how latent variable is explained by observed variables that will be measured through criteria of average variance extracted. Convergent validity indicator means assessment of explanation level of latent variable by its observed variables. Average variance extracted (AVE) has been proposed by Fornell and Larckle (1981) as an indicator to measure internal validity of measurement model. More simply, this indicator shows correlation level of a structure through its own representing indicators. For this indicator, minimum value considered is 0.5 (Holland, 1999); and, this means that concerned latent variable explains at least 50% of its own observed variances. Average variance extracted value bigger than 0.5 would be desirable.

Considering an appropriate value for average variance extracted (AVE) equal to 0.5 and according to the findings in the above table, this criterion has appropriate value in terms of latent variables; so, convergent validity of the research is verified and confirmed.

4.3. Coefficient of Determination Criterion (R^2- R-Squared)

Second criterion to study structural model's fit in a research are coefficients of determination (R^2) related to endogenous (dependent) latent variables of the model. R^2 is a criterion showing effect of an exogenous variable on an endogenous variable and three values of 0.19, 0.33, and 0.67 are considered as criterion values for low, average, and high values of R^2. According to the figure (4-1), R^2 value has been computed for endogenous structures of the research that with consideration of the three

Table 12: Convergent validity results of hidden variables of the research

No	Descriptions of Experimental Research Model Statements		Average extracted variance (AVE> 0.5)
	Farsi define the symbol of the Maknon variables	Define the symbol of the Maknon variables	
1	Important Actions to Manage Operational Risk (Acts)	AC	0.978964
2	The Barriers and Problems of Operational Risk Assessment of the Banking Credit Process	B&Ps	0.946008
3	Background to the Operational Risks of the Banking Credit Process	GORCSPBS	0.809762
4	Identify and evaluate the types of operational risks in the credit system of the Iranian banking system	I&ATORCS	0.910457
5	Improving banks' credit risk management performance	IPBCM	0.878018
6	The main dimensions	MDs	0.512884
7	Important Methods for Operational Risk Management (Methods)	ME	0.821131
8	Important Strategic Risk Management Program (SPs)	SP	0.982660

criterion values confirms structural model's fit. Second criterion to study structural model is the R^2 related to endogenous (dependent) latent variables in the model and shows effect of an exogenous variable on an endogenous variable; and, 0.19, 0.33, and 0.67 are considered ad for the low, average,

and high values of R^2. The more would be the R^2 value related to endogenous structures of a model; better fit of the model would be shown. According to Henseler et al., if an endogenous structure in a model would be affected by one or two exogenous structure(s) , R^2 values higher than 0.33 shows that the relationship between that structure and endogenous structures are strong. Existence of independent variables leads to more increase in R2 (coefficient of determination). Therefore, the more would be the number of independent variables in explaining a dependent variable; the higher R2 value would be required for the model's fit. R2 value near one shows stronger relationship between the variables.

Table 13: Results of the R2 benchmark results for the endogenous construct

Descriptions of Experimental Research Model Statements		R^2
Farsi definition	Symbol Definition	
Important Actions to Manage Operational Risk (Acts)	AC	0.651
The Barriers and Problems of Operational Risk Assessment of the Banking Credit Process	B&Ps	000
Background to the Operational Risks of the Banking Credit Process	GORCSPBS	000
Identify and evaluate the types of operational risks in the credit system of the Iranian banking system	I&ATORCS	0.192
Improving banks' credit risk management performance	IPBCM	0.079
The main dimensions	MDs	0000
Important Methods for Operational Risk Management (Methods)	ME	0.126
Important Strategic Risk Management Program (SPs)	SP	0.507

4.3.1. Q^2 Criterion

This criterion shows predictive power of the model and if its values would be 0.02, 0.15, and/or 0.35 for an endogenous structure; they respectively show low, average, and high predictive powers of the structure or its related exogenous structures. The results shown in the following table are indicative of appropriate predictive power of the model in terms of the research endogenous structures and confirm structural model's fit. Third criterion to study structural model is Q^2(predictive squared correlation coefficient). The criterion introduced by Stone-Geisser (1975) makes predictive power of the model clear in terms of dependent variables. According to them, those models with acceptable level of fit in relation to structure have to be capable of predicting indicators related to endogenous structures of the mode. That is, if relationships between structures in a model are appropriately defined; structures would be capable of sufficiently affecting other indicators so that hypotheses would be correctly confirmed. Values of Q^2 in respect of all of endogenous structures are 0.02, 0.15, and 0.35 as low, average and high predictive power.

4.4. Overall Model Fit

4.4.1. GOF Criterion

To study overall model fit, GOF criterion is used; and, three values of 0.01, 0.25, and 0.36 have been introduced as low, average, and high values for GOF. The criterion would be calculated through following formula:

$$GOF = \sqrt{\overline{communalities} \times \overline{R^2}}$$

Table 14: Results of the R2 benchmark results for the endogenous construct

Descriptions of Experimental Research Model Statements	Descriptions of Experimental Research Model Statements		Coefficient (Q^2)
	Farsi definition of Maknon variables	Define the symbol of the Maknon variables	
1	Farsi definition of current variables Important Actions to Manage Operational Risk	AC	0.633962
2	Identify and evaluate the types of operational risks in the credit system of the Iranian banking system	I&ATORCS	0.171719
3	Improving banks' credit risk management performance	IPBCM	0.066549
4	Important Methods for Operational Risk Management	ME	0.099091
5	Important Strategic Risk Management Program	SPs	0.496591

Where, $\overline{communalities}$ is obtained from average values of commonalties of the research latent variables.

Table 15: Results of Communality and R2 of the Research Variables

Descriptions of Experimental Research Model Statements		Communality	R^2
Farsi definition of Maknon variables	Define the symbol of the Maknon variables	Coefficient of determination	Coefficient of determination
Important Actions to Manage Operational Risk (Acts)	AC	0.978964	0.651
The Barriers and Problems of Operational Risk Assessment of the Banking Credit Process	B&Ps	0.946008	000
Background to the Operational Risks of the Banking Credit Process	GORCSPBS	0.809762	000
Identify and evaluate the types of operational risks in the credit system of the Iranian banking system	I&ATORCS	0.910457	0.192
Improving banks' credit risk management performance	IPBCM	0.878018	0.079
The main dimensions	MDs	0.412885	0000

Table 16: Results of the fitting model of the overall model

Communality	R^2	**GOF**
0.842485	0.311	0.511

Considering the value obtained for GOF (0.51), a very good fit for overall model is confirmed.

4.4.2. Structural analysis of the research variables (structural equations modeling)

Here, research test through Smart-PLS software would be studied.

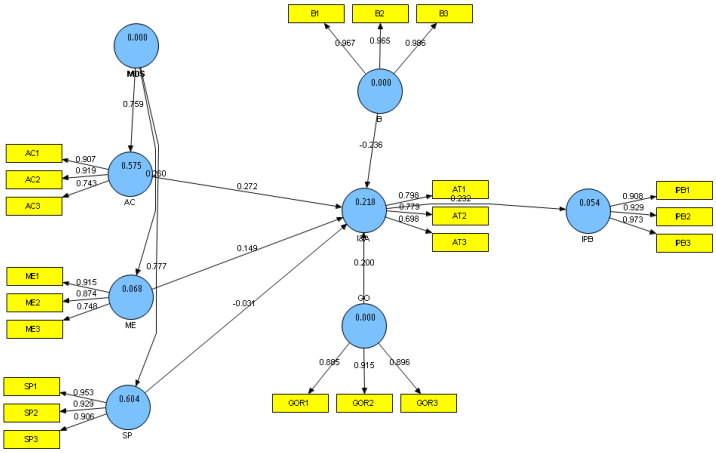

Figure 2: Structural model of research along with factor loading coefficients in fraud risk (FR) model of credit process in banks

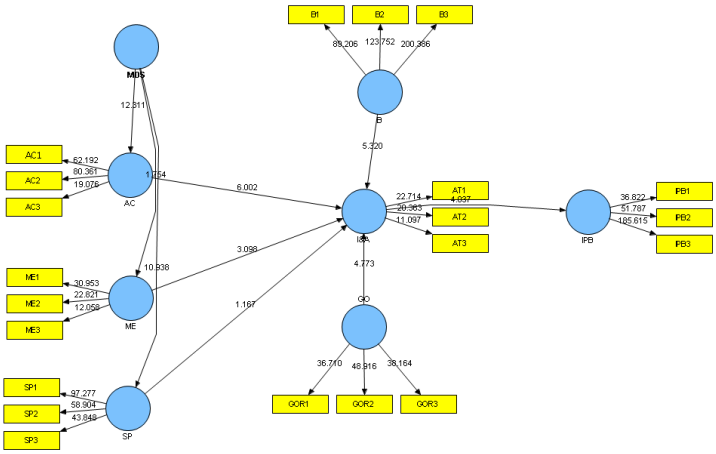

Figure 3: Structural model of research with significant coefficients in fraudulent and fraudulent credit risk banks model FR)Structural model of research with significant coefficients in fraudulent and fraudulent credit risk banks model FR)

4.5. Some explanations regarding estimated structural model

First path analysis

According to the results, it can be suggested that important measures taken in respect of operational risk management has significant effect on identification and assessment strategies of fraud risk in credit process of Iranian Banking System. Also, t-statistic value for the coefficient is higher (1.96) than significance threshold. So, first statistical hypothesis related to this part of the research is confirmed with confidence interval of 95%.

Second path analysis

Based on the results obtained, it can be suggested that important methods in respect of operational risk management have significant effect on identification and assessment of various types of operational risks in credit process of Iranian Banking System. Also, t-statistic value for the coefficient is

higher (1.96) than significance threshold. Therefore, the first statistical hypothesis related to this part of the research will be confirmed with confidence interval of (95%).

Third path analysis

Based on the results, it can be suggested that important strategic program in respect of operational risk management has significant effect on identification and assessment of various types of operational risks in credit process of Iranian Banking System. Also, value of t-statistic for the coefficient is higher (1.96) than significance threshold. So, the first statistical hypothesis related to this part of the research will be confirmed with confidence interval of 95%.

Fourth path analysis

According to the results obtained, it can be indicated that operational risk assessment's obstacles and problems in credit process of banking system has significant effect on identification and assessment of various types of operational risks in Iranian Banking System. Also, value of t-statistic for the coefficient is higher (1.96) than significance threshold; so, first statistical hypothesis related to this part of the research will be confirmed upon confidence interval of 95%.

Fifth path analysis

Considering the results obtained, it can be stated that contextual factors in creating operational risks in credit process of banking system have significant effect on identification and assessment of various types of operational risks in credit process of Iranian Banking System. As far as value of t-statistic for the coefficient is higher (1.96) than significance threshold; first statistical hypothesis related to this part of the research would be confirmed with confidence interval equal to 95%.

Sixth path analysis

Based on the results, identification and assessment of various types of operational risk in credit process of Iranian Banking System can be suggested to have significant effect on improvement of credit risk management performance in banks. Also, value of t-statistic for the coefficient is higher than significance threshold of 1.96. So, first statistical hypothesis related to this part of the research with confidence interval of 95% would be confirmed.

5. Discussion and Conclusion

In financial literatures, credit risk can be attributed to the fact that the other party to a contract fails or would not be willing to abide by obligations set by the contract; and, this is one of the most important risks affecting institutions, especially those with monetary and financial natures. The reason is that, bank loan default with just a few numbers of customers can impose much loss on an organization. In general, credit risk can be considered as probable loss occurring due to a credit event. Therefore, when a customer is faced with financial crisis due to economic weakness and is no more capable of abiding by his obligations; default probability would be increased and credit risk will occur. However, one of the most important risks related to credit field is operational risk; and, in present research, pattern of fraud risk assessment strategies in credit process of banking system in Iran are presented based on empirical evidences obtained from the banks listed in Tehran Stock Exchange. The research is of descriptive type of survey. To do so, with consideration of restrictions existing in making access to total statistical population, sampling has been done from among experts in audit field and those being a member of Iranian Association of Certified Public Accountant, and university professors in accounting and financial management. So, through interview with exerts and executive managers of banks and or observation and review made by the researcher, operational risks related to credit process of banks in Iranian Banking Industry have been identified. To achieve this goal, primarily and to better recognize the research subject, required information have been collected and classified through library and internet studies including books, articles, and case studies. Then,

numerous meetings have been held at presence of financial, risk management and banking experts to review various aspects of fraud risk assessment strategies in credit process of Iranian Banking System. To make the research results more applicable and fruitful, instructions provided by Central Bank of Iran has been completely studied and considered in the research, in addition to identification and assessment instruction as for fraud risk in credit process of Iranian Banking system. Main focus of the research has been put on studying fraud risk through views provided by banking experts, as well as provision of required mechanisms. To do so, through in depth unstructured interviews with managers and experts in the field, initial identification of risks has been done. That is, primarily main experts in credit and banking risk in the banks under study have been interviewed. During interview, they have been asked to introduce other experts in the field. Interviews have been performed in three levels of administrative managers, managers in selected branches of banks, and credit experts in those branches. Interviews have been continued till saturation of data; when, no more new information has been found during new interviews. In next step and through study and analysis of interviews, fraud risks have been identified and extracted and through thematic analysis, identified fraud risks have been classified. Each spectrum of fraud risk assessment strategies in credit process has been placed in one category and then coded. Then, their relationship with activities in credit field has been established. In next step and through preparation of questionnaire and obtaining views provided by experts, severity, probability of occurrence, and probability of detecting risks have been determined and risk priority number (RPN) for each risk has been obtained. To analyze risk mode and its effects, FMEA (failure modes and effects analysis) has been used; and, using risk matrix, coping method with each risk has been specified. Therefore, according to the operational risk analysis results, controlling measures related to fraud risk assessment strategies in credit process of Iranian Banking System can be stated, as they are applicable in different risk levels. In terms of those risks with "risk tolerance" level and low effectiveness and probability of occurrence, undergoing such risk can be tolerated with no action taken. If not tolerable, maybe limited actions can be done in relation to some risks. In such case, through simple trainings and adopting appropriate management arrangements, these risks can be coped with. In terms of those types of risks both with "risk reduction" level and low effectiveness but high probability level of occurrence; setting goals for risk reduction, and taking controlling actions to the aim of making the risk limited to an acceptable level are required. Holding accurate and advanced training courses for bank employees to increase their operational skills according to the Islamic Banking needs of the day, upgrading information technology systems in banks, and removing their weakness points to the aim of more efficiency, eliminating those rules and circulars with lower transparency that can be interpreted differently by persons, as well as adopting appropriate operational and management considerations by senior authorities in banks can play considerable role in reduction and control of these types of operational risks. In terms of those risks with "non-risk taking" level, high effectiveness, and low or average probability of occurrence; best mechanism is their transfer. This could be done through an official and conventional insurance or making payment to a third party for the risk to be accepted by him. This option is especially appropriate for reduction of financial and asset risks. Finally, in terms of those groups of risks with "critical status-immediate action" level, high effectiveness and high probability level of occurrence; some risks can be avoided or treated to an acceptable level through putting an end to the activity. However, some other risks of this group such as risk of slowness and interruptions made in computer network of bank branches and expansion of financial and administrative corruption in case of applying various interest rates in participatory contracts and etc. cannot be eliminated; instead, immediate and emergency actions has to be taken, and more simply "crisis management" has to be done so that their effects that in many cases are very destructive could be controlled.

It goes without saying that, the research results can be compared to those of researches performed

by Wang et al. (2019); Patil et al. (2017); Ikert and Getzert (2017); Urbina and Glain (2014); Mohaghegh Nia et al. (2019); Saghafi et al. (2017); Ahmadi et al. (2016); Abdoli and Fard Hariri (2015); and Yazdani et al. (2016). However, in research performed by Wang et al. (2019), effectiveness of different proposed strategies has been presented based on real credit card data. Analytical framework of big data to process high volume of data as well as execution of different machine learning algorithms have been discussed by Patil et al. (2017) to detect fraud; and, their performance has been observed by them in set of standard data so that frauds will be detected there with low risk and high level of customer satisfaction. It was concluded by Ikert and Getzert (2017) that credit losses can be much severe than operational losses; and, ignoring credit losses will lead to underestimation of various types of operational risks especially fraud risk. This has been in line with the results from present research. In research performed by Urbina and Glain (2014), it was shown that how these principles can be used to distribute capital obtained among different components that cause creation of operational risks. In research performed by Mohaghegh Nia et al. (2019), it was shown that from among variables within banks, size and capital have positive effects on credit risk; and, increase of loans granted has negative effect on it. From among variables from outside banks, centralization, liquidity growth rate, and currency rate growth have positive effect on credit risk; and, variables of development of banking sector and economic growth rate have negative effect on credit risk. In research performed by Saghafi et al. (2017), a three-part framework for comprehensive pattern of credit risk management including policy, methodology, and infrastructure has been found through usage made of research strategy of grounded theory and passing by different coding stages. In research performed by Abdoli and Fard Hariri (2015), it was shown that from among these five variables, variables of average balance (average balance for past six months), ratio of return on sales (ratio of net profit to net sales), current ratio (current asset to current liabilities) have adverse effect on credit risk; and, variables of numbers of bounced checks and ratio of outstanding amount to current asset have direct effect on credit risk. It was shown by Yazdani et al. (2016) through FMEA method that operational risks of Islamic contracts and bank contracts are divided to four general categories of “risk tolerance”, “risk reduction”, “non-risk taking”, and “critical status-immediate action”; and, coping method as well as controlling measured for each of these categories have been introduced so that finally operational risks can be reduced to a level acceptable by bank.

Therefore, with consideration of the results from present research it is proposed that in credit field of banks, more attention would be paid to the issue of various types of fraud risks; and, future researchers are suggested to study the role played by internal control and corporate governance on operational risk management in credit process of banks listed in Tehran Stock Exchange, and to compare their results with those of present research for analysis. It goes without saying that, most important restrictions existing in this research and considered in interpretation of results include: low number of researches with similar subject, including those performed inside the country and out of it due to novelty of the subject.

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