

**OPERATIONAL RISK MANAGEMENT IN INDIAN BANKS : IMPACT OF OWNERSHIP AND SIZE  
ON RANGE OF PRACTICES FOR IMPLEMENTATION OF ADVANCED MEASUREMENT  
APPROACH**

Dr. Yogieta S. Mehra  
Assistant Professor,  
Deen Dayal Upadhyaya College  
(University of Delhi )  
yogieta@gmail.com

**Bio- Sketch of Author**

Dr. Yogieta S. Mehra is an Assistant Professor with Department of Business Studies, Deen Dayal Upadhyaya College of Delhi University. She has more than 12 years of teaching experience in Delhi University and more than three years of corporate experience. She has done her MBE, M.Phil and Ph.D. from Department of Business Economics, University of Delhi. She has numerous research papers to her credit. Her research interest lies in Risk Management in Banks, money market and government securities market.

## **Abstract**

The study aims to explore the range of practices used by Indian Banks in management of operational risk essential for achievement of Advanced Measurement Approach (hereafter referred to as AMA) for a *cross –section of Indian Banks* and perform a comparative analysis with AMA compliant banks worldwide. The study also analyses the impact of size and ownership of banks on the range of operational risk management practices used by the banks through execution of survey comprising of a questionnaire. The Reliability Analysis using Cronbach Alpha model was used to test reliability of questionnaire. KMO Measure of Sampling Adequacy and Bartlett's test of sphericity were used to justify the use of factor analysis as a data reduction technique. Thereafter Factor analysis was performed to extract the most important variables which differentiate performance of one bank from other.

The study provides a conclusive evidence of heightened awareness and due importance given to operational risk by Indian banks. Size was observed to be a deterrent to collection of external loss data , deeper level of involvement of operational risk functionaries, data collection and analysis. The practices of average and small sized public sector and old private sector banks were observed to be lagging behind that of new private sector banks in usage of BEICFs (RCSA, KRIs), usage of scenarios, updating of these indicators and collection and usage of external loss data. Wide gap was observed in the range of practices followed by Indian Banks and the AMA compliant banks worldwide..

**Key Words: Operational Risk, Basel II, AMA, Indian Banks, RBI**

**JEL Classification: G21, G28**

# **OPERATIONAL RISK MANAGEMENT IN INDIAN BANKS : IMPACT OF OWNERSHIP AND SIZE ON RANGE OF PRACTICES FOR IMPLEMENTATION OF ADVANCED MEASUREMENT APPROACH**

## **Introduction**

The worst imaginable times faced by the global financial services sector in 2008 definitely makes it an year to be remembered as the year of shut downs, layoffs, bailouts, bankruptcies, fraud, greed, mis-selling, rogue trading, poor internal controls. The scale and persistence of the credit crisis showed that excessive leverage and unfettered financial innovation - together with improvident credit origination, inadequate valuation methods can escalate market disruptions with adverse consequences for financial stability and economic growth.

An analysis of credit crisis and the failure of financial organisations across the globe makes it apparent that underlying their failure were improperly managed operational risks.. Greed, increasing complexity of banking & financial products, major advances in technology, rapid expansion of bank operations, increasing vulnerability of financial institutions, poor modeling were amongst the causes of this meltdown. All these causes have a striking resemblance with Operational Risk events. It is observed that failure in Operational Risk Management (ORM) by the financial institutions fuelled the subsequent Credit & Liquidity Crisis and the Financial Meltdown which engulfed the world in the closing months of 2008. The root cause of the problem was not the “new” or so-called “unknown risks” from Derivatives, Collateralized Debt Obligations; rather it was the failure of managing Operational Risk.

In light of this crisis, operational risk management has become imperative for all the financial institutions. Indian Banks were relatively protected from the sub prime crisis and faced only an indirect impact of the liquidity crunch post the credit crisis. Strict

lending criteria, no loans to sub prime borrowers with combination of culture and regulations cushioned them from crisis. However, it is imperative to compare the ORM practices of Indian banks with the banks worldwide so as that can become a guiding force for the practices to be followed in future when AMA compliance becomes mandatory. The Basel Committee on Banking Supervision (hereinafter BCBS) performed the Loss Data Collection Exercise 2008 (LDCE) to collect information on all four data elements– internal loss data, external loss data, scenario analysis, and business environment and internal control factors (BEICFs) – used in Advanced Measurement Approach (AMA). This study uses LDCE 2008 as a benchmark to compare the range of operational risk management practices followed by a cross – section of 31 Indian banks of different categories and sizes.

Operational Risk identification and measurement is still in evolutionary stage as compared to the maturity that market and credit risk measurements have achieved. The need for operational risk management is widely recognised by institutions on a global basis. The major areas of concern include definition of operational risk, its measurement and formalisation in theory culture. There is a growing realisation that, efficient operational risk management framework improves and reinforces the internal controls of the organization. Laviada (2007) emphasises that internal audit should be alert to the whole process of implementation of the systems for managing operational risk in entities. Laker (2006) argues that greater complexity of banking activity and increasing dependence on technology and specialist skills has made operational risk as one of the most important risk facing banking institutions of which outsourcing and technology risk are two major sources of operational risk. Davis (2009) observes that the September 11 terrorist attacks changed the debate around operational risk. It had

an impact on firms' operations, as well as economic and regulatory fallout, it raised questions about business continuity, financial crime and processing automation.

Operational risk is not a new risk but it is being increasingly realised by the bankers that many losses earlier described as credit or market risk, were in fact due to failing operational or internal processes. Consiglio and Zenois (2003), Giraud (2005) and Holmes (2003) emphasize upon widely publicized loss events to the lack of operational risk management. They insist that management of operational risk encourages better behaviour amongst firms. Wei (2006) and Cummins J D, Lewis C M and Wei R (2006) examined that declines in market value due to announcement of operational loss events were of a larger magnitude than the operational losses causing them. Skinner (2008) asserts that the growth and survival of firms amidst intense competition depends upon the management and control of operational risks. In response to recent incidents, such as the sub-prime crisis in the US and internet disruption to businesses in Asia, the Middle East and North Africa caused by damaged undersea cables, Marshall (2008) feels that there is need to take a cross-department approach to risk management and business continuity strategies.

Various approaches have been suggested to manage operational risk in the past. Damian Williams (2008) argues against firms' predominating "silo approach" to risk management since it results in a lack of knowledge and transparency in an organisation leading to greater operational risk and consequently losses resulting from failed internal processes and systems.

The main focus in operational risk management approaches worldwide has been excessive reliance on different financial models. The models developed over the years failed to predict and prepare the firms for the catastrophe. It was further observed that frequency and severity of losses observed by AMA compliant banks

with well developed models were more as against non AMA banks. The reasons given are that probably these banks are much larger as compared to non AMA, hence the frequency and severity is also more. There is one more possible reason that the organizations failed to pick up early warning signals from the output of these models and alerts and actively manage them. A holistic operational risk management program requires both qualitative and quantitative information, but how can one integrate risk self-assessment, control self-assessment, internal loss data, external loss data, VaR modelling, scenario analysis, audit issues, indicators, etc. into a common framework that supports managerial decision making. Our paper attempts to fill the gap and explore the range of qualitative methods of operational risk management and suggests an appropriate qualitative criterion for Indian banks.

Kalyvas L, I. Akkizidis, I. Zourka, and V. Bouchereau (2006) argue that the AMA measurement system must take into account internal data, external data, scenario analysis, and internal controls and business environment factors. Haubenstock and Hardin (2003) listed some additional steps, including the development of scenarios for stress testing and incorporating scorecards and risk indicators. This implies that the scenario-based approach and the scorecard approach are used to adjust the capital charge calculated by using the LDA.

Reynolds and Syer (2003) also endorse the opinion of Kuhn and Neu (2005) and mention the IMA, LDA and SCA as separate approaches but not the SBA. A contrary view expressed by Fujii (2005) indicates how the “scenario based advanced management approach (AMA) provides solutions to some of the problems (of the LDA)”. Chapelle et al. (2004) argue that while the AMA could encompass any proprietary model, the most popular AMA methodology is by far the LDA.

Operational risk models encompass a variety of statistical and econometric models designed to measure the regulatory and economic capital to be held against operational risk, and also models designed to study its causes and consequences. Peccia (2003) argues that modelling operational risk has become important because the environment in which banks operate has changed dramatically. Rao and Dev (2006) argue that the AMA is as much about managing operational risk as of measuring and calculating regulatory capital. Bolton and Berkey (2005) appreciate that the “Sound Practices paper” provides an excellent outline for designing an operational risk management framework that can provide tangible benefits that does not get distracted by the challenges of operational risk modelling.

The Basel II has defined the use of internal data, external data, scenario analysis, and Business Environment and Internal Control Factors (BEICFs) as elements of estimation of operational risk under AMA of which Scenario Analysis and Business Environment and Internal Control Factors (which include use of Risk and Control Self Assessment, Key Risk Indicators and Scorecard Approach) have been listed out as qualitative methods used to achieve AMA compliance. Haubenstock., M. (2003) believes that KRIs are most useful when the volume of transactions is high. Iyer (2006) clarifies that “KRI is not a measure of risk, it is an indicator of riskiness”. Dev Ashish (2007) appreciates the rising popularity of Risk & Control Self-Assessment (RCSA) as an operational risk management tool. He observes that RCSA is increasingly being used as a means of more fully assessing the effectiveness of the risk management framework of a bank from an operational risk perspective. Chapelle A, Y Crama, G Hubner, and J P Peters (2004) review the rules of Basel II regarding the treatment of operational risk, and focused on four axes of operational risk management, viz., Incident Reporting, Dashboards, KPIs, KRIs and RCSA.

Kumar Vijay T. (2008) observes that, (RCSA) is a process through which operational risks and the effectiveness of controls are assessed and examined to provide assurance that all business objectives would be met. Jim Ryan and David Shu (2007) analyse the global survey on operational risk management and observe maturity of foundational activities, such as loss event collection and risk control self-assessments (RCSA), but an immature state for scenario analysis, capital modelling and key risk indicators indicating increasing popularity of RCSA among various Operational Risk management techniques.

Wood (2008) advocates the use of RCSA and KRI approaches as they are a lot more objective and, provide the necessary focus for corrective action, leading to truly controlling operational risks rather than just measuring it, and hence is more effective. The Loss Data Collection Exercise (LCDE) carried out by BCBS in 2008 is clearly an evidence of the growth of banks worldwide in the field of modelling and management of operational risk. Researchers doubt India and Brazil banks lagging far behind their peers from US, UK, Japan and Australia in all respects of operational risk management right from methods of data collection to the analysis of data and development of appropriate models using the same. Many banks in these countries have already received AMA accreditation reflecting their advancement in the field of ORM.

It can be argued that in light of the crisis and growing market it is imperative to explore the present state of practices in Operational Risk Management (ORM) being followed by Indian banks and find out the banks which are far behind their peers in ORM and hence more exposed to the risk . The present paper attempts to explore the limiting criteria for banks (size or category) which do not have a well developed operational risk management system. This would bring to light the various



shortcomings of Operational Risk Management system of Indian Banks and help in overcoming them.

***Objectives of the Study :*** The key objectives of this study are :

- Explore the range of operational risk management practices followed by Indian banks and compare with practices of different banks worldwide.
- Perform a cross comparison of range of operational risk management practices for advanced approaches to Operational risk management in various categories i.e., public sector, private sector (old), private sector (new) and foreign banks in India.
- Explore key factors essential in the management of operational risk in Indian Banks.

The data used for the study is both primary and secondary viz., questionnaire collected from risk practioners (Chief risk officers / official in the Operational risk management department / Risk management department) in a cross section of 31 banks and the response of 121 banks worldwide collected by LDCE 2008. Statistical analysis of the primary data has revealed some of the important facts about the Indian Banks like status of implementation of operational risk management, their range of practices w.r.t. advanced approaches of management of operational risk in light of Basel II disclosures while factor analysis has explained the most distinguishing factors amongst the sample banks.

The Basel II accord requires that AMA banks incorporate internal loss data, external loss data, scenario analysis, and business environment and internal control factors (BEICFs) into the modelling of operational risk capital. The questionnaire also seeks to assess the status of Indian banks in these *four* critical essential for achieving AMA.

Primary data contains information of fourteen public sector banks, five old private sector banks, seven new private sector banks and five foreign banks. The survey questionnaires were sent to these banks in the month of July 2009. The written / e-mailed responses to the questionnaires were received between August 2009 and September 2009. This was followed up by personal visits or phone calls in order to gain further insight into the implementation of operational risk management by these banks. The sample distribution is provided in Table 1.

**Table 1 : Description of Sample Banks assessed in the survey**

	MNC size	Large Size	Average Size	Small size	Total
Public Sector	2	5	4	3	14 (45%)
Private Sector (Old)	----	----	3	2	7 (23%)
Private Sector (New)	----	3	3	1	5 (16%)
Foreign Bank	5	----	----	----	5 (16%)
	7 (23%)	8 (26%)	10 (33%)	6 (19%)	

The 14 public sector banks constitute 45% of the sample, 5 each Private Sector (old) and foreign banks represent 16% each of the sample size. The sample includes all 7 private sector banks (new) operating in India comprising 23% of the sample. The banks were categorised as MNC, large, average or small sized on the basis of assets. This will help to explore a possible relationship between the size of the bank and various strategies and practices vis-à-vis operational risk.

The Reserve Bank of India has clearly articulated the approach for implementation of Basel II for commercial banks in India. (RBI 2007a, 2009) Under these guidelines, all commercial banks in India are required to adopt the Basic Indicator Approach (BIA) for operational risk to begin with, and the entire commercial banking sector has begun Basel II compliance since March 2009. As of April 2010, all the banks in India follow the BIA approach for operational risk capital computation as against the trend in US,

Europe, Japan and Australia. Of the 121 banks covered by LDCE 2008, 42 were AMA compliant, 51 followed TSA and 20 banks followed the BIA approach ( 8 non AMA banks of U.S. were not included as BIA and TSA were not available). As per the roadmap released by Reserve Bank of India on advanced approaches to be followed by Indian banks , the likely date of approval by RBI (Notification 2009) for introducing AMA (Advanced Management Approach) in Indian banks is March 31, 2013.

All the 31 banks displayed a well defined *policy for Operational Risk Management* approved from their respective boards in most of the cases. In most of the banks, operational risk is managed by a division of the risk management department. The LDCE 2008 considers *involvement* as a significant factor since it is believed that deeper involvement leads to better effectiveness of the operational risk management programme. Wide variation were reported in involvement of operational risk functionaries at different banks. MNC size and large sized banks (including public sector, new private sector and foreign banks) have involvement at the zonal level and at some respondents even at branch level. However, the involvement is limited to the head office at small and average sized banks. All the respondent banks have an exclusive CRO reflecting the sincerity of Indian banks towards risk management. Chi square test revealed significant relationship between the level of involvement and bank category (p value .042) and size of the bank (p value .000).

*Frequent reporting by operational risk head* ensures regular checks of the framework and timely detection of errors. Most of the respondent banks had a system of quarterly reporting. None of the public sector banks had a monthly reporting system, however most of foreign banks reported monthly and 43% of the private sector (new) banks as well as private sector (old) banks (20%) had a monthly reporting system. The

relationship between bank category and frequency of reporting was observed to be *significant* (p value .003).

**Table 2 : Frequency of reporting by Operational risk head**

	Quarterly	Monthly
Public Sector Banks	14	
Private Sector (old)	4	1
Private Sector (New)	4	3
Foreign Banks	1	4

**Basel II guidelines** have listed out seven different event types *categorized as operational risk*. These event types have been categorized on the basis of historical experience of various operational risk based loss events in the past. These events range from internal and external fraud to employment practices, damage to physical assets amongst others. The opinion of respondents as to which particular event is perceived as most important by them is listed out in Table 3.

**Table 3 : Ranking of Event Types by different category of banks**

		Public Sector	Private Sector (old)	Private Sector (New)	Foreign Bank	$\chi^2$ test (p value)
Internal Fraud	Most Important	12	4	7	5	0.923
	Important	2	1			
	Neutral					
	Not Important					
External Fraud	Most Important	3	2	3	1	0.272
	Important	5	3	2	4	
	Neutral	6		2		
	Not Important					
Employment Practices & Workplace Safety (EPWS)	Most Important	4	--	2	1	0.15
	Important	6	5	1	2	
	Neutral	4	--	4	2	
	Not Important					
Clients, Products & Business Practice	Most Important	5	2	1	2	0.835
	Important	8	2	4	2	
	Neutral	1	1	2	1	
	Not Important					
Damage to	Most Important	2	1	0	0	0.033
	Important	0	2	0	3	

Physical Assets	Neutral	11	2	5	2	0.232	
	Not Important	1		2	0		
Business Disruption and System Failure	Most Important	9	2	2	2		
	Important	5	2	5	3		
	Neutral		1	--	--		
	Not Important						
Execution, Delivery & Process Management	Most Important	3	2	3	--		0.423
	Important	6	--	2	2		
	Neutral	5	3	2	3		
	Not Important						

**Table 4 : Sum and Distribution of annualised frequencies by Business line and Event type**

Table ILD 4A  
Sum and Distribution of Annualised Loss Frequencies by Business Line and Event Type

	Internal Fraud	External Fraud	Employment Practices & Workplace Safety	Clients, Products & Business Practices	Damage to Physical Assets	Business Disruption & System Failures	Execution, Delivery & Process Management	All	Business Line Losses as Percent of All Losses
Corporate Finance	3.5	11.5	21.6	100.2	2.4	4.6	69.1	212.9	0.7%
	1.7%	5.4%	10.2%	47.0%	1.1%	2.2%	32.5%		
Trading & Sales	32.2	31.7	96.9	398.6	12.2	157.6	2,400.6	3,129.9	9.6%
	1.0%	1.0%	3.1%	12.7%	0.4%	5.0%	76.7%		
Retail Banking	979.4	7,311.9	3,203.4	2,381.0	245.4	293.8	3,743.4	18,158.3	55.8%
	5.4%	40.3%	17.6%	13.1%	1.4%	1.6%	20.6%		
Commercial Banking	69.6	710.4	104.3	504.4	30.1	65.2	1,196.8	2,680.8	8.2%
	2.6%	26.5%	3.9%	18.8%	1.1%	2.4%	44.6%		
Payment & Settlement	20.5	185.3	23.3	50.7	21.7	37.5	386.0	725.1	2.2%
	2.8%	25.6%	3.2%	7.0%	3.0%	5.2%	53.2%		
Agency Services	11.3	94.5	12.8	44.9	5.9	26.8	698.9	895.0	2.7%
	1.3%	10.6%	1.4%	5.0%	0.7%	3.0%	78.1%		
Asset Management	10.7	19.1	30.3	96.5	1.9	22.9	522.8	704.2	2.2%
	1.5%	2.7%	4.3%	13.7%	0.3%	3.2%	74.2%		
Retail Brokerage	196.5	75.9	149.4	2,247.0	2.4	16.1	672.7	3,359.9	10.3%
	5.8%	2.3%	4.4%	66.9%	0.1%	0.5%	20.0%		
Unallocated	50.5	124.7	2,072.4	91.6	61.0	17.8	280.1	2,698.2	8.3%
	1.9%	4.6%	76.8%	3.4%	2.3%	0.7%	10.4%		
All	1,374.3	8,564.9	5,714.5	5,914.9	382.9	642.3	9,970.5	32,564.3	100.0%
	4.2%	26.3%	17.5%	18.2%	1.2%	2.0%	30.6%		

Note 1. Losses of € 20,000 or more in the stable dataset.

Note 2. First row for each business line: Sum of annualised loss frequencies.

Note 3. Second row for each business line: Distribution of losses across event types.

Basel event types with the highest frequency of losses were Execution, Delivery, and Process Management (EDPM), followed by External Fraud. The event type with the highest annual loss amount was Clients, Products, and Business Practices (CPBP). Losses reported for Business Disruption and System Failures and Damage to Physical Assets were relatively lower. .

Amongst the respondents, all the private sector banks and foreign banks consider Internal Fraud to be most important operational risk event. Overall 90% banks rate Internal Fraud as the most important Operational Risk and 10% perceive it be important. Sub Prime Crisis is an evidence of external fraud event taking place in US can cause havoc on Indian entities. Other examples of external fraud include robbery, forgery, cheque kiting, damage from computer hacking. Most of them (75%) believe it to be important where as 25% are neutral about External Fraud as an Operational Risk. All old private sector banks and foreign banks consider it to be an important factor. The relationship between type of bank and the factor is not significant. *The events Employment Practices & Workplace Safety Practices, Clients, Products & Business Practice and Business Disruption and System Failure* were considered important by most of the banks. Indian Banks should not ignore these factors as major losses have been observed in these event types as indicated by the LDCE 2008. No significant relationship was observed between the factor and the category of bank implying that all type of banks share similar opinions about these factors. Most of the respondents (74%, mainly public sector banks) were either neutral or did not consider the event *Damage to Physical Assets (Natural Disaster, Terrorism)* as important. A change in mindset is required here as recent past is testimony of India's vulnerability to terrorism. The variation in importance given to the *event* by different categories of banks is significant (p value 0.033).

*Identification of operational risk inherent in Material Activities* is the stepping stone to efficient ORM. Overall, 58% respondent banks have initiated the process of identification of Operational Risk inherent in Material Activities but only 36% public sector banks and 20% private sector (old) banks have initiated the process. Even the relationship between the category of bank and process of identification of operational risk inherent in material activities is significant (p value .001). Banks which have not started this process do not realise that identification of operational risk inherent in material activities would help them take appropriate precautionary measures to minimise instances of loss due to operational risk.

*Use of Internal Loss data* : The respondents were not comfortable in sharing loss data, hence the responses were restricted to the practices in the internal loss data. Banks need to collect a minimum of three years of *Internal loss data* for developing the model for AMA. All the banks in India are collecting the Internal Loss Data. There is variation in the time period since when they have been doing this.

**Table 5 : Use of Internal Loss as input in different categories of banks**

Bank Category * Input Internal Loss Crosstabulation			
	Input Internal Loss (% within bank category)		
	Past 1 year	1 - 3 years	More than 3 years
Public Sector	28.6%	21.4%	50.0%
Old Private sector	.0%	60.0%	40.0%
New Private Sector	.0%	28.6%	71.4%
Foreign Bank	.0%	.0%	100.0%
Total ( % out of 31)	12.9%	25.8%	61.3%

61% respondents have been collecting internal loss for the past three years or more. This difference between category of the bank and collection of internal loss data is not significant (p value 0.104). Internal loss data of banks is insufficient for the purpose of modeling since operational risk has a heavy tail distribution due to presence of low

frequency high intensity (LFHI) events . Banks supplement their internal loss data with external loss data to get the right kind of distribution. External loss data is collected by an agency which maintains a pool of loss data of its member banks or through magazines, periodicals, and trade reports. Very few respondents have been collecting external loss data for more than an year and all these are large public sector banks. Non availability of an agency to pool external loss data of Indian Banks till February 2009 is the main reason responsible for this. Also the banks which have not yet initiated the process of modelling operational risk do not realise the importance of collecting external loss data. 45% respondents have been collecting external loss data for the past one year which includes all foreign banks, 70% private sector (new) banks, 40% private sector (old) banks and 14% public sector banks.

**Table 6 : Use of External Loss as an input in different category of banks**

Bank Category * Input External Loss Data Crosstabulation				
	Input External Loss			
	Do not use	Past 1 year	1 - 3 years	More than 3 years
Public Sector	64.3%	14.3%	14.3%	7.1%
Old Private sector	60.0%	40.0%	.0%	.0%
New Private Sector	28.6%	71.4%	.0%	.0%
Foreign Bank	.0%	100.0%	.0%	.0%
Total	45.2%	45.2%	6.5%	3.2%

*Use of BEICF tools* : BEICFs are indicators of a bank's operational risk profile that reflect underlying business risk factors and an assessment of the effectiveness of the internal control environment. They provide a forward-looking element to an AMA by considering Business Environment indicators (eg the rate of growth, employee turnover, and new product introductions) and Internal Control Factors (eg findings from the challenge process, internal audit results, and system downtime). As one of



the four elements of an AMA framework, BEICFs should be incorporated, either directly or indirectly, into the operational risk measurement process.

As per the BCBS report, all AMA banks now use some type of BEICF tool for risk management and/or risk quantification. The most commonly used BEICFs tools are RCSAs (98%), audit results (90%), and KRIs/KPIs (81%).<sup>21</sup> Use of the three major BEICF tools across the globe is similar, though KRIs/KPIs are used in only 43% of Japanese AMA banks. Nearly all of AMA banks use RCSAs (95%), audit results (88%), or KRIs/KPIs (81%) as tools to manage operational risk.

**Table 7 : Use of BEICF Tools by AMA banks as per LDCE 2008**

Number and Percentage of Banks by Region

	All Participating AMA Banks		Australia		Europe		Japan		North America	
<b>Number of AMA Banks</b>	42		5		20		7		10	
<b>Using RCSAs</b>	<b>#</b>	<b>%</b>	<b>#</b>	<b>%</b>	<b>#</b>	<b>%</b>	<b>#</b>	<b>%</b>	<b>#</b>	<b>%</b>
For Risk Management Purposes	40	95%	5	100%	19	95%	6	86%	10	100%
Used Directly or Indirectly for Risk Quantification	32	76%	3	60%	16	80%	6	86%	7	70%
Not Used	1	2%	0	0%	0	0%	1	14%	0	0%
<b>Using KRI/KPIs</b>	<b>#</b>	<b>%</b>	<b>#</b>	<b>%</b>	<b>#</b>	<b>%</b>	<b>#</b>	<b>%</b>	<b>#</b>	<b>%</b>
For Risk Management Purposes	34	81%	5	100%	18	90%	3	43%	8	80%
Used Directly or Indirectly for Risk Quantification	19	45%	3	60%	12	60%	2	29%	2	20%
Not Used	8	19%	0	0%	2	10%	4	57%	2	20%

Note: Banks were able to select more than one answer per question.

Source : BCBS Report 2008;: Observed range of practice in key elements of AMA.

An analysis of annual reports of Indian banks shows that all the banks which intend to move to AMA in future would be using RCSA (*Risk Control Self-Assessment*).

Only one fourth of the respondents have been using RCSA as an input for more than 3 years. The difference in usage of RCSA at present by different categories of banks is *significant* ( p value 0.004). Public sector banks and private sector (old) lag behind their counterparts in use of RCSA as a key input since they have not started preparing for the advanced approaches for capital calculation of operational risk. Indian banks have not yet realized the potential benefit of the *Scorecard approach* since majority of those surveyed do not use it as yet in measurement of operational risk capital. When they prepare themselves for the advanced approaches, perhaps the usage of scorecards would also improve. Use of *Key Risk Indicators and Key Performance Indicators* is very popular worldwide. Some banks have more than 1000 KPIs / KRIs which are used as an input in their operational risk measurement method. However, amongst Indian banks , one- third of the respondents do not use KPIs / KRIs as an input. These banks have not yet realised that usage of KPIs / KRIs helps in identification of potential operational risk events and take appropriate steps to minimise it. Half of surveyed public sector banks are using it, 60% of the private sector (old), most of the private sector (new) and all the foreign banks use KPIs / KRIs as a key input. The difference in usage of KPIs / KRIs by different categories of banks is *significant* ( value .031).

*Scenario Analysis* is a popular input in the OR measurement methodology and is essential for going AMA. Worldwide, the banks with AMA accreditation have made extensive use of scenarios. Amongst respondent banks, one – third do not use scenarios as an input in their measurement methodology. All the foreign bank respondents used scenario analysis (40% of them have been doing it for more than 3 years). Chi Square tests suggest that the relationship between use of scenario analysis

is *not significant* with respect to size (p value .288) but it is *significant* with respect to the category of bank (p value .001).

<b>Table 8 : Bank Category * Input Scenario Analysis Cross tabulation</b>				
	Input Scenario Analysis			
	Do not use	Past 1 year	1 - 3 years	More than 3 years
Public Sector	57.14%	35.7%	7.1%	.0%
Old Private sector	40.0%	40.0%	.0%	7.1%
New Private Sector	14.28%	0%	85.71%	.0%
Foreign Bank	--	--	60%	40%
Total	35.5%	22.60%	32.2%	9.7%

*EVT (Extreme Value Theory)* is a quantitative modeling method suitable for operational risk since there are instances of extreme data points and heavy tail in operational risk. Once Indian banks prepare for the AMA accreditation, use of EVT will be inevitable. However, as of now, 68% of the respondents do not use EVT in their measurement methodology while others have incorporated it in the *past one year*. The p value (.046) between category of bank and use of EVT is *significant*.

**Ranking of operational risk reporting components:** Banks have the liberty of reporting quantum of operational risk using data from a variety of components, viz., internal loss data, external loss data, Scenarios, BEICFs (RCSA and Key Risk Indicators) However, the present study aims to identify the component considered most important by maximum respondents.

*Internal Loss data:* Collection of internal loss data is imperative to any advanced approach of capital calculation of operational. This is clearly evident from the observation that all respondents rated internal losses as *most important* operational risk reporting component. This reflects that all respondents unanimously feel that internal loss data collection is essential for effective ORM.

*External Loss data:* Collection of external loss data is essential for quantitative modeling of operational risk. However, it is only as recent as February 2009 that the

first external loss data collection pool exercise has been initiated by the IBA in India. Only 13 banks have taken this membership of providing their loss data to it so as to create a varied and valid external loss database. The banks have not yet realized the importance of including external loss data to model operational risk so only 11% respondents rated external loss data as most important. This reflects relative non acceptance of external loss as a reporting component. 51% respondents rate external loss as important. 80% respondents each from old private sector banks and foreign banks believe the same. Overall, 38% respondent rank external loss as neutral reporting component. Chi Square test reveal that the relationship between category of banks and ranking of external events is not significant.(p value .159) reflecting a relative casual attitude of banks towards the factor.

*Scorecard / RCSA*: There is a varied opinion about ranking of RCSA as an operational risk reporting component. Many Indian banks mention in their annual reports, that they would use RCSA as their main approach in future for AMA modeling but it seems the awareness about its importance has not percolated as yet. Only 16% respondents rate it as *most important*. 7% respondents from public sector banks, 40% from old private sector and 29% from new private sector banks are part of this group. 55% respondents rate RCSA as an *important* rating component and 40% rate it as *neutral*. Chi square test reveal that there is no significant relationship (p value .509) between category of banks based on ownership and ranking of RCSA approach.

*Key Risk Indicators* : Indian banks are still in the process of developing their range of KRIs. This is the reason that only 19.4% respondents report KRIs to be the most important operational risk reporting component. There is very varied opinion about the ranking of KRIs amongst different categories of Banks. More than half of the respondents from all categories of banks rank KRIs as an *important / most important*

reporting component of operational risk. Chi square test also reveal that there is no significant relationship (p value .779) between category of banks based on ownership and Ranking of KRI as an operational risk reporting component.

*New Product Risks:* The first Principle of BCBS's Sound Practices paper insists upon the banks' board to regularly review their operational risk framework, This would ensure that bank is managing operational risk associated with new products, activities or systems. It has been observed that one of the most prominent causes of sub prime crisis was the inappropriate rating of highly sophisticated, structured and complex derivative products. Indian banks also have started realizing the importance of risks emerging from New Products. This is evident in the observation that new product risk is ranked most important by as many as 45% of the respondents. All the foreign banks, most of private sector (new) banks (71%) and very few respondents from public sector banks (21%) and private sector (old) banks (20%) share this opinion. This reflects the sensitivity of private sector (New) and foreign banks towards importance of the risk from new products. Some respondents (23%) do not feel it is important since they do not come up with new product too often. *Significant* relationship is observed between new product risk rating and category of banks (p value.038).

*Internal loss has emerged as the most important reporting component followed by risks from new product then key risk indicators.*

*Collection and usage of Internal and External Loss Data:* Collection of internal loss data is the first step to measurement of operational risk. 52% respondents collect data of all internal losses and near miss as well which is the best collection method as suggested by analysts. Other respondents collect either losses over a floor value or all

losses. All banks should be encouraged to maintain near miss database as well. Chi square test do not reveal any reveal any significant relationship between size of the bank and internal loss data collection method (p value .184) and with respect to category of the bank (p value .230) as well.

In February 2009, IBA (Indian Banks Association) formed an *external loss database* and is encouraging all the banks to share their data with it. Banks also use newspaper clippings and market intelligence banks to build up external loss database. The survey results indicate that only the respondents from MNC size and among the largest banks of country collect and scale external loss data. 52% respondents have not even started collecting any external loss data. Chi Square test reveal a *significant* relationship between collection & usage of external loss data and the size of the bank (p value .009) and with the category of bank (p value .004). This implies that small size of the bank is a hurdle in collection and usage of external loss data.

*Data Collection and Analysis:* Significant progress has been made in data collection and analysis by 39% respondents mainly comprising all the respondents from foreign banks and few from private sector (new) (29%), public sector (29%) and old private sector (20%) have made significant progress. 48% respondents have made good progress comprising 57% new private sector banks, 80% old private sector banks and 50% public sector banks. This is an indicator that Indian banks have started focusing on data collection and its analysis as it is an integral requirement of operational risk management. Chi Square test indicates significant relationship between progress in data collection and analysis and category of the bank (p value .074) and size of the bank (.068).

*Progress in Quantification & Modeling of Operational Risk:* The modeling of operational risk is required only when banks attempt for AMA accreditation. BCBS

(2008) observes that one of the major distinguishing features of operational risk models is how the models combine internal loss data, external data, scenario analysis and business environment and internal control factors (BEICFs).

As per RBI stipulations, Indian banks cannot apply for AMA before April 2013. However, the preparation for the same must start by now. Good Progress has been made in this field only by 16% respondents comprising mainly foreign banks and very few Private Sector Bank (old) and (new) banks. Process of Modeling has been started by 36% banks which includes relatively higher proportion of private sector banks (new) and foreign banks. Almost half of the respondent banks (48%) are yet to begin the process of modeling of Operational Risk comprising most of the public sector banks (79%) and old private sector banks (60%). It is observed that yet again progress of public sector banks and private sector (old) lags behind those of private Sector (new) and foreign Banks. Chi Square test also show a *significant relationship* between bank category and progress in Quantification & Modeling (p value .004).

**Table 9 : Progress in Quantification and Modelling Techniques by different categories of banks**

	<b>Yet to begin</b>	<b>Process has started</b>	<b>Good Progress</b>
Public Sector Banks	11	3	
Private Sector (old)	3	1	1
Private Sector (New)	1	5	1
Foreign Banks		2	3

The LDCE 2008 carried out by BCBS is clearly an evidence of the growth of banks worldwide in the field of modeling and management of operational risk management. The sample banks from India and Brazil lagged far behind their peers from US, UK, Japan and Australia. The difference is visible in all aspects with respect to operational risk ranging from methods of data collection to the analysis of data and development of appropriate models using the same. Many banks in these countries

have already received AMA accreditation reflecting their advancement in the field of ORM.

*Frequency of updating of BEICF tools* : A frequent KRI review helps in including new indicators and doing away with the redundant ones. 39% respondents do not have any fixed review frequency while others do it annually / bi-annually. Few private sector (old and new) banks and most of the foreign banks review their KRIs every six months. A significant relationship (p value .003) has been observed between bank ownership and frequency of KRI review.

There is a wide range of practice in the frequency with which BEICF tools are updated in the AMA practising banks as per the BCBS survey. RCSAs are updated generally either on an annual basis (43%), quarterly to semi-annual basis (26%), or semi-annually to annually (24%). KRIs/KPIs are updated more frequently, typically monthly to quarterly (52%). Audit results are updated to reflect the risk based nature of the audit process, with a wide range of practice noted. Audit scores or findings are most often reviewed when triggered (26%), or updated more frequently on a monthly (19%), annual (19%), quarterly (14%) or semi-annual basis (17%). There is some regional variation in how BEICFs are updated. AMA banks in Europe (85%) and Japan (71%) typically update RCSAs less frequently than other regions.

**Table 10 : Updating of BEICF Tools : KRI / KPIs**



Number and Percentage of Banks by Region

	All Participating AMA Banks		Australia		Europe		Japan		North America	
<b>Number of AMA Banks</b>	42		5		20		7		10	
<b>Updating KRI/KPIs</b>	<b>#</b>	<b>%</b>	<b>#</b>	<b>%</b>	<b>#</b>	<b>%</b>	<b>#</b>	<b>%</b>	<b>#</b>	<b>%</b>
Annually	4	10%	0	100%	3	15%	0	0%	1	10%
Semi-annually to Annually	4	10%	1	20%	3	15%	0	0%	0	0%
Quarterly to Semi-Annually	8	19%	2	40%	5	25%	0	0%	1	10%
Monthly to Quarterly	22	52%	2	40%	13	65%	2	29%	5	50%
More frequently than Monthly	2	5%	0	0%	2	10%	0	0%	0	0%
Reviewed when triggered	4	10%	0	0%	3	15%	0	0%	1	10%
Not Used	8	19%	0	0%	2	10%	4	57%	2	20%

Note: Banks were able to select more than one answer per question.

*Source : Report 2008;: Observed range of practice in key elements of AMA.*

The **factor analysis** has been used to decipher **critical factors** that distinguish the sample banks from each other. This will lead to awareness amongst banks about selective factors which need to be given relatively more significance to develop a healthy operational risk management structure. **Reliability analysis** provides an overall index of the repeatability or internal consistency of the scale. The Reliability Analysis using Cronbach Alpha model and Factor Analysis has been performed separately on the three sections of questionnaire.

Section 1 of the survey analysed the practices used by respondents for movement to advanced approaches of operational risk capital calculation. 15 variables including existence of a framework, usage of various quantitative and qualitative inputs and frequency of their review were considered for factor analysis. The value of alpha in reliability analysis is 0.928, implying contents of the questionnaire are reliable. The

value of KMO Measure of Sampling Adequacy(0.832) and significance value of Bartlett's test (0.000) justify the use of factor analysis as a data reduction technique.

**Table 11 : Total Variance Explained of components of Section 1**

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	<b>7.760</b>	51.730	51.730	7.760	51.730	51.730	3.797	25.314	25.314
2	<b>1.775</b>	11.837	63.567	1.775	11.837	63.567	3.667	24.447	49.762
3	<b>1.282</b>	8.545	72.112	1.282	8.545	<b>72.112</b>	3.353	22.350	<b>72.112</b>
4	.969	6.459	78.571						
5	.639	4.261	82.832						
6	.598	3.987	86.819						
7	.474	3.157	89.976						
8	.356	2.374	92.350						
9	.332	2.210	94.560						
10	.287	1.910	96.471						
11	.157	1.047	97.517						
12	.111	.740	98.257						
13	.099	.659	98.916						
14	.095	.632	99.548						
15	.068	.452	100.000						

Factor analysis reduced the set of 15 factors to 3 factors which together explain 72 % of variance.

**Table 12 : Rotated Component Matrix for factors affecting Present Status of ORM Implementation**

	Component				Component		
	1	2	3		1	2	3
Identify OpRiskin	.693	.217	.173	EVT	.031	.827	.183
RobustF/W	.311	.459	.664	VaR	.058	.747	.121
Int Loss data	<b>.722</b>	.241	.354	Others	.709	-.100	.090
Ext Loss data	.597	.598	-.226	Whatdata	.709	.092	.391
RCSA	.346	.440	.665	Ext Loss Method	.301	<b>.861</b>	.182
ScrCard	.138	-.205	<b>.819</b>	FreqKRI	.601	.360	.575
KPI	.531	.367	.546	ORFrmwrk	.642	.464	.451
Scenario	.215	.526	.720				

Rotated Component Matrix reveals that the three factors important in differentiating present status of ORM implementation amongst Indian banks are : (i) Usage of Internal Loss Data, (ii) Usage of Methods of External Loss data collection and (iii) Usage of scorecards in operational risk measurement and management.

The next section compiled the range of practices used by respondents with respect to usage of various inputs into their risk control and progress strategy. The section observes and analyses progress of respondents on a range of factors suggested by the Basel II document. These comprise ranking of various operational risk reporting components, frequency of updating them, progress in data collection and analysis and progress in quantification and modelling.

The value of alpha in reliability analysis is 0.946, implying that the contents of the questionnaire are reliable. The value of KMO Measure of Sampling Adequacy (0.691) and significance value of Bartlett's test (0.000) justify the use of factor analysis as a data reduction technique.

**Table 13 : Total Variance Explained by components of Section 2**

Component	Total Variance Explained								
	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	10.908	51.942	51.942	10.908	51.942	51.942	5.176	24.645	24.645
2	2.132	10.154	62.097	2.132	10.154	62.097	5.017	23.893	48.538
3	1.356	6.459	68.556	1.356	6.459	68.556	3.233	15.397	63.935
4	1.129	5.377	73.933	1.129	5.377	73.933	2.099	9.998	73.933
5	.988	4.706	78.639						
7	.746	3.550	83.459						
8	.535	2.548	89.007						

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
9	.500	2.381	91.388						
10	.269	1.279	96.254						
11	.020	.096	99.946						
12	.011	.054	100.000						

Factor analysis has reduced the set of twelve variables to four factors which together explain 74 % of variance.

**Table 14 : Rotated Component Matrix for factors affecting Risk Control and Reporting Progress.**

Rotated Component Matrix				
	Component			
	1	2	3	4
RateIntCntrl	.660	.358	.266	.327
RankExtEvent	<b>.813</b>	.057	-.012	.144
ScrCard/RCSA	.338	-.070	.015	<b>.815</b>
KRIs	.079	.479	-.025	.775
NewPrdct	.486	<b>.730</b>	.233	.055
ReportKRI	.221	.297	<b>.724</b>	-.006
MitigtOR	.602	.638	.046	.269
ProgrsIdenti	.207	.478	.325	-.330
ProgrsData	.165	.645	.355	-.259
ProgrsMgmt	.340	.693	.313	.253
ProgrsModel	.566	.461	.305	.007
IntAudit	.623	.344	.529	.202

Rotated Component Matrix reveals that the four factors important In Risk Control and Reporting Progress are : (i) Ranking of External events as an operational risk reporting component (ii) Level of progress made with respect to ranking of Scorecard / RCSA as an operational risk reporting component (iii) Ranking of New Product Risk as an operational risk reporting component and (iv) Frequency of updating of KRIs/ KPIs.

Overall, the factor analysis has led to the extraction of 7 factors. Banks must endeavour to give maximum emphasis to these factors to minimise relative anomalies in their performance and preparation for advanced approaches to ORM. Further, this would create an overall operational risk aware culture in all the organisations.

The study of operational risk management practices of a range of banks in India and other countries give a conclusive evidence of heightened awareness and due importance being given to operational risk. The practices followed evidence of a pragmatic mix of qualitative and quantitative aspects. The sub-prime crisis has made the organizations more conscious and as a result all new products are subject to risk review and sign-off process for identification and assessment of relevant risks. AMA is on the agenda of many banks and they are gearing up for it by collecting relevant data. Although organizational structures continue to differ on their strategies and systems, there is a consistent trend of operational risk departments reporting under the purview of Chief Risk Officer. Size was observed to be a deterrent to deep involvement of operational risk functionaries, collection and usage of external loss data and data collection and analysis. Large sized banks had a well developed framework / model for operational risk management / measurement as compared to their peers. Numerous areas emerged where the performance / preparedness of public sector and old private sector banks was observed to be lagging behind that of new private sector and foreign banks. Significant difference amongst different category of banks was observed in usage of key reporting components like RCSAs, KRIs, usage of Scenarios, collection and usage of external loss data, data collection and analysis, quantification & modelling and updating of KRIs. All the banks are collecting the *Internal Loss Data*. However, many Indian banks have not even started collecting *external loss data*. Though *RCSA*, *Scenario analysis*, *EVT* and *KPI / KRI* are widely

used as an input by Indian banks but the proportion of public sector banks and private sector (old) banks using them is lower. Significant progress in the field of Quantification & Modelling of Operational Risk was made by very few respondents.

**It can further be recommended** that public sector banks (esp. small and average sized) and private sector banks (old) must gear up their progress towards implementation of operational risk policies, usage of RCSA and key risk indicators. Small and average sized banks can use the experience of their bigger counterparts in tiding over the hurdles in implementation of advanced approaches to capital calculation of operational risk. The Indian banks should learn lesson from sub-prime crisis that regular updating of self-assessment results, scenario analysis results and KRIs based on relevant reports is more important than the numbers themselves. RBI should consider giving relaxations to large banks in early adoption of AMA approach.

#### **References :**

1. Allen, L. and T. G. Bali. 2007. Cyclicity in catastrophic and operational risk measurements. *Journal of Banking and Finance*, 31(1): 1191-1235.
2. Alvarez Gene. 2006. Operational Risk Economic Capital Measurement: Mathematical Models for Analyzing Loss Data. In Ellen Davis (Ed.), *The Advanced Measurement Approach to Operational Risk*. London : RISK books.
3. Basel Committee on Banking Supervision. 2004. *International Convergence of Capital Measurement and Capital Standards- A Revised Framework*. (June).
4. BCBS. 2003a. *Sound Practices for the Management and Supervision of Operational Risk*, Bank for International Settlements.

5. Bolton, N. and Berkey, J. 2005. Aligning Basel II Operational Risk and Sarbanes-Oxley 404 Projects. In E. Davis (Ed.), *Operational Risk: Practical Approaches to Implementation*. London : Risk Books.
6. Cagan, P. 2001. Seizing the Tail of the Dragon. FOW, Operational Risk, July 2001, 18–23.
7. Chapelle, A., Crama, Y., Hubner, G. and Peters, J. P. 2004. *Basel II and Operational Risk: Implications for Risk Measurement and Management in the Financial Sector*. Unpublished paper, National Bank of Belgium.
8. Consiglio, A. and Zenios, S. A. 2003. Model Error in Enterprise-wide Risk Management: Insurance Policies with Guarantees. In *Advances in Operational Risk: Firm-wide Issues for Financial Institutions* (second edition). London: Risk Books.
9. Crouchy, M., Galai, D., and Mark, R. 1998. Key Steps in Building Consistent Operational Risk Management and Measurement. In *Operational Risk and Financial Institutions*, London: Risk Books.
10. Cummins, J. D., Lewis, C. M., and Wei, R. 2006. The Market Value Impact of Operational Loss Events for US Banks and Insurers. *Journal of Banking and Finance*, 30 (1): 2605–2634.
11. Damian, Shaw-Williams. 2008. Sub prime crisis highlights need for enterprise wide risk management. *Datamonitor*. January.
12. Davis, E. 2009. Loss Data Collection and Modelling. In E. Davis (Ed.), *Operational Risk: Practical Approaches to Implementation*, London: Risk Books.
13. Dev, Ashish. 2007. Driving Value Creation in a Post-Basel II Era. In *Operational Risk 2.0*: September: 328- 35.

14. Farmer, David. 2008. Sub-prime crisis a matter of poor accounting, *OpRisk Austega.com*.(March):
15. Fujii, K. 2005. Building Scenarios, *Operational Risk: Practical Approaches to Implementation*. In E. Davis (Ed.), London: Risk Books.
16. Giraud, J. R. 2005. Managing Hedge Funds Exposure to Operational Risks. In E. Davis., (Ed.), *Operational Risk: Practical Approaches to Implementation*, London: Risk Books.
17. Hadjiemmanuil, C. 2003. Legal Risk and Fraud: Capital Charges, Control and Insurance. In C. Alexander. (Ed.), *Operational Risk: Regulation, Analysis and Management*. Prentice Hall-Financial Times
18. Hashagen, Jorg. 2003. *Framework for Managing Operational Risk*. White paper, Basel – II closer look, KPMG.
19. Haubenstock, M. and Hardin, L. 2003. The Loss Distribution Approach. In C. Alexander (Ed.), *Operational Risk: Regulation, Analysis and Management*. Prentice Hall-Financial Times.
20. Holmes, M. 2003. Measuring Operational Risk: A Reality Check. *RISK*, 16 (1): 84– 87.
21. Iyer, Jaidev.2006. *Op Risk and Compliance*. May: 7 (5)
22. Jim, Ryan. and David, Shu. 2007. Bridging the risk gap source. *OpRisk & Compliance*, December.
23. Kalyvas, L., I. Akkizidis, I. Zourka and Bouchereau, V. 2006. Integrating Market, Credit and Operational Risk. *In A Complete Guide for Bankers and Risk Professionals*. London: Risk Books.
24. Kuhn, R. and Neu, P. 2005. *Functional Correlation Approach to Operational Risk in Banking Organizations*. Working Paper, Dresdner Bank AG.



25. Kumar, Vijay T. 2008. The methodology behind Risk and Control Self Assessments. *gt news.com., article 7032.*
26. Laker, John. F. 2006. The Evolution of Risk and Risk Management – A Prudential Regulator’s Perspective. *Chairman’s Speech, Australian Prudential Regulatory Authority.* September.
27. Laviada, Ana Ferna’ndez. 2007. Internal audit function role in operational risk management. *Journal of Financial Regulation and Compliance.* 15 (2), 143-155.
28. Lopez, J. A. 2002. What is Operational Risk? *Economic Letter, Federal Reserve Bank of San Francisco.*
29. Marshall, Rosalie. 2008. Firms need to broaden risk outlook. *IT Week,* Feb
30. Medova, E. A. and Kyriacou, M. N. 2001. *Extremes in Operational Risk Management.* Unpublished paper, University of Cambridge.
31. Peccia, A. 2003. Using Operational Risk Models to Manage Operational Risk. In C. Alexander (Ed.), *Operational Risk: Regulation, Analysis and Management,* London: Prentice Hall-Financial Times.
32. Quick, Jeremy. 2006. The Advanced Measurement Approach: Getting it Started. In Ellen Davis (Ed.), *The Advanced Measurement Approach to Operational Risk ,* London: Risk Books.
33. Rao, V. and Dev, A. 2006. Operational Risk: Some Issues in Basel II AMA Implementation in US Financial Institutions. In E. Davis (Ed.), *The Advanced Measurement Approach to Operational Risk,* London : Risk Books.
34. *RBI Notification.* 2009. Introduction of Advanced Approaches of Basel II Framework in India – Draft Time Schedule.

35. Reynolds, D. and Syer, D. 2003. A General Simulation Framework for Operational Loss Distributions. In C. Alexander (Ed.), *Operational Risk: Regulation, Analysis and Management*, Prentice Hall -Financial Times.
36. Skinner, Chris. 2008. Dresdner leads with global accounting. *IT Week* , Feb.
37. Turing, D. 2003. *Advances in Operational Risk: Firm-wide Issues for Financial Institutions (second edition)*. London : Risk Books.
38. Webb, A. 1999. Controlling Operational Risk. *Derivatives Strategy*, 4 (1), 17–21.
39. Wei, R. 2006. *An Empirical Investigation of Operational Risk in the United States Financial Sectors*. Working paper. The Wharton School, University of Pennsylvania, Philadelphia, PA.
40. Wood, David. 2008. In the thick of it. *OpRisk & Compliance*. February.