Allied Commercial Bank of Connecticut –
Operational Risk and Total Quality Management

The Allied Commercial Bank of Connecticut (ACBC), is a major bank with headquarters in Hartford, Connecticut. The bank is a holding company with several subsidiaries, the two largest ones being the ACBC Retail Bank, which has hundreds of branches in Connecticut and New England, and the ACBC Investment Bank which has offices in Hartford and New York City. The ACBC Retail Bank has a number of divisions, one of them being the credit card division which offers Visa as well as MasterCard cards. The ACBC Investment Bank conducts typical investment banking activities such as Mergers and Acquisitions (M&A), and securities trading, including Foreign Exchange (FX) trading.

Part I: The ACBC Retail Bank – Credit Cards

The credit card division within the retail bank has around 120 million account holders and the number increases with a rate of approximately 1% a year.

Courtney McClelland is an operations analyst in the credit card operations of the ACBC Retail Bank. The team that McClelland is a part of is responsible for analyzing, managing, and solving the bad debt due to fraudulent or erroneous charges, also known as credit card operational risk which the company has to deal with. Fraudulent charges may have various different causes, including

(i) Lost or stolen cards
(ii) Counterfeit cards
(iii) Unsecure internet payment systems
(iv) Theft of cards from mail or non-receipt of issue
(v) Mail telephone/telephone/Internet order fraud
(vi) Merchant fraud
(vii) Bankruptcy fraud (cardholder makes purchases on the card for which he has no intention on paying).

What makes the situation worse is that over the last couple of years the information systems of several large retail chains have been hacked and the credit card information of millions of customers had been stolen (in 2013, Target had been hacked and the credit card information of 40 million of its customers had been stolen).
At ACBC data for bad credit card debt (due to some form of fraud) is compiled monthly-48 months have been demonstrated on the attached (.xlsx) file. For strictly the sake of more coherent data analysis and policy making, the aggregate for every month is reported to her division in USD Millions and is rounded to two decimal points. Note that this form of bad debt is different from credit card losses that are being incurred because of account holders filings for bankruptcies; those losses may be classified as credit risks (those accounts should not have been opened in the first place).

The majority of credit card operational risk is weighted by "charge back" complaints from customers who do not feel a transaction was made justly onto their account. Usually the customer claims a charge as false or as an unauthorized charge potentially made by someone else illegally on his or her account. The process of a charge involves paperwork and hierarchical communication to retrieve proof of sale (i.e., signed receipts) from the original seller to compare to the challenge made by the consumer. More so than not, the challenge is usually granted and the credit card issuer has to face the loss as operational risk.

The most challenging part of managing credit card operational risk, especially with growing technology making it easier to make purchases from a distance, is that it is almost impossible to prove the identity of the card user without any dispute. With non-swipe transactions such as those made on the Internet or by telephone, it is almost impossible to trace back to the person who made the initial purchase - leaving an open window for fraud. Many credit card issuers have implemented defensive strategies, but many times they end up being more expensive than the bad debt itself.

The four year period that McClelland had been presented recently demonstrates several interesting patterns in the distribution of operational risk losses. First, the bad debt shows some increase over the years. It seems that the average amount of bad debt may increase at a rate of about 5% a year. This annual increase may be due to inflation as well as increases in the number of credit cards outstanding. Another interesting pattern is that the end of the year (around December) typically shows a higher rate of bad debt that the company collects. The general speculation is that this is due to the heavy shopping habits during the holiday season and therefore the higher the likelihood of people disputing charges. Keeping this in mind, McClelland is given this data set to determine how detrimental the end of the year holiday season really is to the distribution of the average bad debt. Based on the results of this study, the company may be able to manage its operations better during that time of the year, having more information. For example, it may be able to improve its estimates for the numbers of operators needed at its call centers during that time of the year and thus reduce expected customer waiting times.

Exercises Part I

1) General Assessment of Data and “Influence Diagram”
a) What are the most important variables that affect the operational losses of a credit card portfolio? Are there any composite factors that we should consider (a composite factor being a function of two or more variables)?

b) Draw an “influence diagram” depicting the variables and the factors that may be of importance in determining the operational risk losses of a credit card portfolio. If in the influence diagram a variable (or factor) affects another variable (or factor) then the influence diagram should show an arrow (and the arrow should also show whether the impact is positive or negative.)

c) Are the impacts of the factors that affect the operational losses additive (i.e., linear) or do they reinforce one another in one sense or the other? Describe any reinforcements. How would such reinforcements work?

2) Preliminary Data Analysis
   a) Perform a descriptive statistical analysis of the data in the accompanying Excel file CreditCardDataSet(Exercises1-2)(forStudent).xlsx concerning the Credit Card losses. In addition to descriptive statistics, show a histogram and a time series graph.
   b) Does the data approximate a normal distribution? Why or why not? Are there any adjustments you can make to the data so that it approximates a normal distribution better? Perform descriptive statistical analysis, as well as a histogram and time series graph, of your adjusted dataset.
   c) Would the difference between the months at the end of the year and the other months be statistically significant?

3) Distribution Fitting
   Try to fit a probability distribution to the adjusted loss data given using Excel or Crystal Ball. How well do the data match the normal distribution? Evaluate the quality of the fit of the normal distribution.

4) Control Chart
   Assume that the data are normally distributed. Create an X-bar control chart based on these data. Compute the Center Line and the 3-sigma Upper and Lower Control Limit (UCL and LCL). On which data are you going to base your computations of the Center Line, the UCL and the LCL? Is the process in control?

5) Assumptions
   What do you think are the most important parameters of the credit card portfolio that affect the monthly expected operational risk losses?

6) Changes in Parameters
   Assume that the average credit card limit up to now has been $20,000. The company considers increasing the average credit card limit to $30,000. What do you think will
happen with the average monthly operational risk losses? Will it go up also by 50% (or more or less)? Are the operational risk losses increasing concave or increasing convex in the average credit card limit?
Part II: The ACBC Investment Bank –
Foreign Exchange (FX) Trading

Andre Dehnad is a Senior Vice-President at the ACBC Investment Bank. Andre is in charge of the Capital Markets division that is responsible for equity trading (proprietary and client), fixed income trading (proprietary and client), as well as Foreign Exchange trading (client). Every day by the end of trading hours he receives a report showing the daily aggregate operational loss figures incurred due to errors made by his traders (e.g., wrong information on the trade forcing it to be redone, interest compensation for delays in settlement, etc.).

The transaction-processing environment in a financial institution is not much different than in a factory: trades need to be captured by the internal systems, enriched with extra information by operations and then settled either directly with counterparty or in an exchange. However, unlike in a factory, the variance in the daily trading volume can be huge, making difficult to plan for an ideal level of resources. In addition, banks and financial institutions have a historic cultural disregard for the processing of transactions and operations. The focus of these firms has always been the revenue side, where most of the resources traditionally have been allocated.

As a consequence of fails in many steps of transaction processing, operational losses occur and may be caused by various factors, including systems downtime, heavy trading volumes (which put additional stress on his traders), and so on.

On the regulatory side, according to the Basel Committee, and endorsed by local regulators as the FED, OCC, etc., banks have been required since 2004 to develop frameworks to control and measure the operational risks to which they are exposed. Banks were given some time by the regulators to adapt to the new rules and in 2012 they need to have these models up and running. These charges are heavy and following the simplest approach, namely the Basic Indicator Approach (BIA), banks need to allocate 15% of their net revenue to cover against such risks. Larger banks cannot use simple approaches and need to invest in more sophisticated methods to measure operational risk, using as inputs, among other data, their own history of operational losses and key risk indicators that reflect the status of the control environment. Banks like ACBC need to measure operational risk using these more sophisticated approached (AMA – Advanced Measurement Approach) and an increase in losses can thus impact their capital base.

Andre Dehnad is rather worried about the figures he is seeing. He sees that on several days the operational losses were very significant and understands that the impact of these losses is not just in the bottom line but also imply an increase in the capital base that has to be allocated against his business, reducing the profitability. He requires a deeper analysis of the situation and where the Capital Markets Division needs to focus in order to reduce losses and capital; he asks his assistant to set up a meeting with the Chief Risk Officer (CRO).
The CRO immediately sets up a meeting and asks the Head of Operational Risk (OR), Shirley Liu, to begin a data analysis project. In a meeting with her team, the Head of OR speculated about what type of probability distribution would fit these loss data. In particular she is concerned about what the upper tail of the distribution would look like, because that tail represents the most significant financial losses. She knew that the fatter the tail, the larger the Operational Value at Risk would be. She expected that with such a distribution of losses, the corresponding Operational Value at Risk (Ops-VaR) may well be close to 1 billion dollars (computed following the guidelines specified by Basel II). Having to keep so much capital in reserve would significantly reduce the profitability of the firm and the company’s management most likely would not like that. Shirley Liu imagines that, with these figures, Andre Dehnad would of course also not be very happy.

Shirley realizes that the operational losses she is looking at are an aggregation of the losses incurred by the three separate groups that make up Andre Dehnad’s division, namely, equities, fixed income, and foreign exchange (FX). In order to be able to do a rigorous analysis, she needs more detailed data. Andre must start looking at more detailed data of the losses incurred in each one of his three different groups. Andre decides to set up a meeting with the three Vice-Presidents in charge of the three desks in order to see what can be done in a systemic way in order to reduce the losses. In addition, he is thinking of inviting a consultant specializing in Total Quality Management (TQM) to attend the meeting as well. He requests his three VPs to provide him with daily operational loss data in each one of the three groups as well as the values of factors that may be affecting the losses, e.g., minutes of system down time each day, number of traders present, trading volume, etc.

After a week of frantic data collection, his three Vice-Presidents finally provide him with the requested data. Actually, it is immediately clear from the data that each group is subject to different factors that affect their daily operational losses. Even if two of the groups are subject to a similar factor, then the impact of the common factor may be different for the two groups. (Attached are the data that came from the third group, i.e., FX trades.)

Andre is thinking that, in order to reduce his daily operational losses, he may have to make some investments. He has two broad options:

(i) He can hire additional operation officers. That way he reduces the number of daily trades by each operations officer (reducing the stress level and therefore also the error rate). Hiring one additional trader may well cost the company 400K a year.
(ii) He can upgrade processing systems (either hardware or software), e.g., by adding servers that have a higher capacity. During the days with a higher trading volume, the probabilities of down times are reduced and with less system down time, the number of errors are then most likely reduced as well. The person in charge of IT has told Andre that a one-time investment of 2 million will reduce the system down times by 40%.
(iii) He may want to do a combination of (i) and (ii).
At his meeting with the three VPs, the TQM consultant advises to apply a standard statistical technique called Multiple Regression. Basically, Multiple Regression is a regression technique that tries to establish the relationships (either linear or nonlinear) between the daily operational losses and the values of the independent variables. The functions may then give some clues with regard to the directions in which Andre should make additional investments.
Exercises Part II

7) General Assessment of Data and “Influence Diagram”
   a) What are the most important variables that affect the operational losses in FX trading? Are there any composite factors that should be considered (a composite factor being a function of two or more variables)?
   b) Draw an “influence diagram” depicting the variables and the factors that may be of importance. If in the influence diagram a variable (or factor) affects another variable (or factor) then the influence diagram should show an arrow (and the arrow should also show whether the impact is positive or negative.) Include “system downtime” as a potential variable in your influence diagram.
   c) Are the impacts of the factors affecting operational losses additive (i.e., linear) or do they reinforce one another in one sense or the other? How would such reinforcement work?

8) Preliminary Data Analysis
   a) Perform a descriptive statistical analysis of the data presented in the accompanying Excel file (TradingDataSet_I_(Exercises8-13)(forStudent).xlsx) with 106 FX trades. In particular, determine the mean, standard error, standard deviation, variance, and range of each variable. In addition to descriptive statistics for each variable, show a histogram and a time series graph for each variable.
   b) Do you see any anomalies in the data that are hard to explain?

9) Distribution Fitting
   Try to fit a probability distribution to the loss data using Excel or Crystal Ball. How good is the fit of the normal distribution? How good is the fit of the lognormal distribution? What are the best fitting distributions, and what do they have in common?

10) Distributional Comparison with Credit Card Losses
    Compare the distribution of the Operational Risk losses of the credit card division with the distribution of the Operational Risk Losses in the FX Trading division. Give an argument why one loss distribution comes closer to the normal distribution than the other loss distribution.

11) Correlation Analysis
    a) Create a correlation matrix for all variables in the Excel file TradingDataSet_I_(Exercises8-13)(forStudent).xlsx. Which variables might be useful in explaining the variation in operational losses?
    b) Create Excel scatter diagrams in which operational loss is plotted on the vertical (Y) axis. Create a graph with each of the other variables plotted on the horizontal (X) axis.
    c) Use the Excel trend line feature to try both linear and nonlinear fits. Which relationships seem to exhibit nonlinearity?
12) **Linear Regression Analysis**

The objective in this part is to construct a regression model to explain how `Losses` (dependent variable) are affected by the remaining explanatory (independent) variables: (i) Errors, (ii) Cancels/Corrects, (iii) Breaks, (iv) Fails, (v) Trades, and (vi) Headcount.

a) Based on the preliminary data analysis in Exercises (7), (8), and (11), can you identify independent variables that you would like to remove from the data because (i) they are highly correlated to other explanatory variables or (ii) they seem to have minimal impact on explaining `Losses`. Explain your criteria.

b) Using only those independent variables that you did not remove in part (12-a), construct a multivariate linear regression to estimate how `Losses` are affected by these independent variables. Compute the R² (R-square) statistic and comment on the explanatory power of your model. Use your results to determine the significance of each explanatory variable.

13) **Composite Variables and Linear Regression**

Andre Dehnad is particularly concerned with the impact that `Trade by Headcount` is having on `Losses`. Create a new composite variable `trades/headcount`, which basically represents the average workload that a trader is subject to.

a) Create a correlation matrix for all variables (independent and dependent) in the data set including the additional variable `trades/headcount`. Which variables may be the most useful in explaining the variation in operational losses?

b) Using `Trade by Headcount` as one of the explanatory variables, construct a linear regression model to explain variation in losses. Can you identify independent variables that you would like to remove from the data because (i) they are highly correlated to other explanatory variables or (ii) they seem to have minimal impact on explaining `Losses`. Explain your criteria.

c) Choose you model trying to maximize the R² (R-square) statistic. Briefly explain your choice.

14) **Composite Variables and Nonlinear Regression**

Consider the Excel file `TradingDataSet_II_(Exercise14)(forStudent).xlsx` which has 106 trades and three independent variables: trades, headcount, and downtime. Using `Trade by Headcount` and the down time as the two explanatory variables, construct a non-linear regression model to explain variation in losses. Choose either a nonlinear function of the Trade by Headcount and/or a nonlinear function of the downtime trying to maximize the R-square statistic. Briefly explain your choice.
15) System Design and Control
Use your results in Exercise 12 to answer the following questions:

a) What is the probability that Losses will exceed $100,000 in a day in which the number of Trades by Headcount is equal to 1,000 trades?

b) In a day with 20,000 trades, what is the minimum number of traders required to guarantee that Losses will not exceed $100,000 with 90% probability.

c) Using the available data, fit a normal distribution to the number of trades per day. Using this distribution and assuming that there are exactly twelve traders working, simulate 100 days to estimate the average and standard deviation of daily losses.

d) Explain how you can construct and use an X-chart to monitor the performance of the FX desk. Assume that the target (average) for daily Losses should be around $60,000.

16) Final Recommendations
What inferences can you make from your analysis in Exercises 7, 8, 9, 12, 13, and 14 above? If you had 5 minutes of Andre’s time, what would you tell him about the operational loss problem at the FX desk? What actions should he take in order to mitigate operational losses?
Glossary

Advanced Measurement Approach (AMA) - This is the most advanced method to calculate regulatory capital under the Basel 2 rules. In this method banks are allowed to use their own models to calculate operational risk capital. There are many requirements to be fulfilled; however, usually banks see a benefit in moving to AMA as their operational risk capital usually will be lower than 15% of the gross revenue as it would be the case for the Basic Indicator Approach (BIA, see below). In the US the largest 20 banks need to be under AMA as indicated by the FED.

Basel Committee – Supra-national committee composed by central bankers and banking regulators of the largest economies. This committee establishes the basic rules for banks to estimate and allocate capital to protect their activities. The rules established by the Basel Committee are then turned into law and regulation by each participating country. For operational risk, the Basel Committee established 3 methods to allocate capital, the Basic Indicator Approach (BIA), the Standardized Approach (SA) and the Advanced Measurement Approach (AMA).

Basic Indicator Approach (BIA) – The basic level of capital required to financial institutions to protect against operational risks. It is equivalent to 15% of the gross revenue.

Breaks – When a transaction cannot be processed by some reason (incomplete information, system issues, etc) it is called a break as in “there was a break in the process”.

Cancels & Corrects – A term used in a financial institution back office to say that a trade was either cancelled or have its terms and conditions (financial or not) amended by either party in agreement. Most banks back offices use this indicator, usually just called “C&C”, as an important measure of the quality of its operations. Regulators also like to use this metric as a gauge to assess the quality of operations and back office of a financial institution.

Downtime – Length of time in minutes that a system is offline or incapable of processing transactions

Equity – In this case, equity means stock or shares. Equity market is where stock of open or public companies are negotiated

Error - Any type of processing error (e.g., wrong account information, wrong counterpart details, etc) that leads to a transaction not being settled.

Fails – When negotiating a stock a bank is supposed to deliver and receive these stocks into their custody. Any fail in receiving or delivering is called “Fail”. This is another important indicator of the quality of back office process

FED – FEDeral Reserve Bank, a US regulator for major banks.

Fixed Income – Area in a bank that deals with bonds and similar instruments
**Foreign Exchange (FX) trade** - An FX trade in the futures or forwards market is a contract that agrees that at a certain specified time in the future, i.e., at the maturity date (say 1 year in the future), a certain amount of currency A is exchanged for a certain amount of currency B with the counterparty at the exchange rate that is specified in the contract.

**Operational Loss** – Losses caused by operational errors and failures. Examples are interest payments to compensate counterparties for errors in processing transactions, losses due to internal frauds, etc.

**Operational Value at Risk (Ops-VAR)**
Assume that we either know (approximately) the distribution function of the total amount of operational losses over an entire year. Or, that we have a way of simulating operational losses over a year through the knowledge of a frequency distribution of operational events and the loss severity distribution of a random event. The Ops-VAR is that level for which the probability of the total annual losses due to operational events surpassing it, is only 0.1%

**P&L adjustments** – This is another important indicator of a bank’s back office quality. Most times a processing error occurs it will involve adjusting the profit & loss (P&L) of a transaction. For example, suppose that a trader bought 100 shares of company ABC and recorded the price at $1.00. As the price closed at $1.10 the books and records stated a $10 profit for his account. However, it was noted later that the counterparty said that the real purchasing price was actually $1.10 (the $1.00 price was recorded in error by the trader) so the financial controllers had to make a P&L adjustment of -$10 to correct that.

**Proprietary desk** – Trading desk that deals with a bank’s own money and positions (not client related)

**SWIFT (Society for Worldwide Interbank Financial services and processes)** – A society that has contributed in a major way to the standardization of services and processes, resulting in significant productivity and quality improvements. SWIFT supplies secure messaging services and interface software to financial institutions. It thus must have reduced the frequencies of occurrences of operational risk events.

**Trades** – A transaction made with a counterparty negotiating either equity, fixed income, FX, derivatives, etc.

**Value at Risk (VaR)** – After a probability distribution of the losses over a given time horizon $H$ has been determined ($H$ being typically one year), the $x\%$ VaR of the losses can be determined (the $x\%$ being typically 99.9%). The $x\%$ VaR is that level of loss for which the probability of the total annual losses due to operational risk events surpassing it, is only 0.1%
Videos for the ACBC case

https://www.youtube.com/watch?v=3HBx_N7_tz0&index=18&list=PLue8TeHAgWZEmhr6D1fcC- zrdxM9DiQ4A
https://www.youtube.com/watch?v=UU1i9EJerKI&index=17&list=PLue8TeHAgWZEmhr6D1fcC- zrdxM9DiQ4A
https://www.youtube.com/watch?v=cbRRH2yFpbQ&index=16&list=PLue8TeHAgWZEmhr6D1fcC- zrdxM9DiQ4A