

Using Excel to Teach Simulation for Management Accounting

By Clarence Goh, Ph.D., CA (Singapore); Poh-Sun Seow, Ph.D., FCA (Singapore); and Gary Pan, Ph.D., FCA (Singapore)

EXECUTIVE SUMMARY

Data analytics skills have become essential—even mandatory—for accountants to cultivate more certainty in data that can help with better decision making. Companies are now pushing for new graduates to have these skills. An Excel exercise in a management accounting class highlights how to build simulation models, an important data analytics skill set for accountants. This article introduces a three-phase implementation process for instructors that ultimately guides students to solve a management accounting problem using simulation models in Excel.

The role of accountants is rapidly changing, with accountants increasingly being expected to go beyond their traditional areas of financial reporting and control to provide higher value insights that management can use to make strategic decisions. To allow accountants to effectively do so, skill sets in data analytics are critical. According to a survey of more than 2,100 CFOs by staffing resources firm Robert Half, 61% of respondents said expertise in data analytics was deemed mandatory for accounting and finance employees.¹

Consistent with the results from the survey, universities have also reported that major companies have reached out directly to accounting schools to emphasize the importance of data analytics skills for new accounting graduates.² In response, universities have begun to rethink the accounting curriculum and progressively introduced technology skills, particularly in data analytics, that will have a vital role to play in the future of accounting.³

While technological advances have led to the emergence of many sophisticated data analytics tools, many accounting practitioners and educators continue to highlight that proficiency in Excel remains a fundamental skill set for accounting graduates.⁴ For example, Usha Ramachandran Rackliffe and Linda Ragland conducted a survey of accounting professors that asked them to rate, on a 10-point scale

(one corresponding to “not important” and 10 to “extremely important”), the extent that they believed it was important for accounting students to be proficient in Excel before graduation.⁵ The mean rating of 9.09 suggests that accounting professors strongly feel that proficiency in Excel is important for accounting graduates. In another survey of accounting and finance professionals, Wendy Tietz, Jennifer M. Cainas, and Tracie L. Miller-Nobles found that employers also consider proficiency in Excel a much-needed skill for business school graduates.⁶

The strong emphasis on Excel proficiency is unsurprising given that it is a versatile tool that many companies continue to rely on when performing data analysis.⁷ In addition to basic data analysis, practitioners can use Excel to perform complex data analytics. In the accounting context, complex data analytics techniques using Excel include regression and optimization.⁸

Besides accounting, simulation is a data analytics technique that has applications in various areas of business, including operations management and finance. The essential element of a simulation involves replacing constant estimated values within mathematical models with probability distributions to reflect uncertainty in decision inputs and replicate studies many times, drawing instances of outcomes from these distributions for each replication. The simulation results will vary, reflecting the variety of data distributions.⁹ Given that decision making in the accounting context is often subject to outcome uncertainty, practitioners can effectively apply simulations across various functional areas in accounting to improve decision making.

We introduce an Excel exercise on simulation that instructors can implement in a management accounting class. Specifically, we introduce a three-phase implementation process where instructors:

- Give the class an introduction to simulation.
- Introduce students to a four-step process involved in conducting analysis using simulation in Excel.
- Introduce a simulation problem focused on a specific area of management accounting (revenue projection), and guide students in completing the simulation analysis in Excel.

We highlight how instructors can use a common tool such as Excel to conduct analysis involving complex data analytics techniques like simulation in the management accounting context. In addition, we provide specific guidance to accounting educators on how to implement simulation in Excel in a management accounting class. This exercise in class will provide insights to accounting students on how they can use simulation to solve problems in management accounting (and in other areas of accounting) and at the same time improve their proficiency in Excel. Our contribution to practice highlights how accountants can use simulation to address problems involving uncertain inputs that they commonly face.

LITERATURE REVIEW

Prior literature suggests practitioners can apply simulation in various areas of accounting. In the area of fair value accounting, Kian Hui Ng and Elisa Noble examined auditors’ considerations relating to the choice of an option-pricing model for calculating the fair value of share options and suggested that although various models, including the Black-Scholes model, binomial model, and simulation model, may be appropriate, share options are generally better valued with a simulation model when they include market performance conditions.¹⁰

Relatedly, Dmitry Pugachevsky, Rohan Douglas, and Roman Bedau examined model-based fair value measurements of over-the-counter derivatives and discussed the computation of related credit value adjustments (CVA) and debit value adjustments (DVA).¹¹ They noted that practitioners can use less computationally intensive methods based on simple approximations in these computations; the “best practice methods” are those that are based on simulations.

In the area of management accounting, Virginia Clark, Margaret Reed, and Jens Stephan examined how practitioners can apply simulation models to capital budgeting projects to visualize risk and uncertainty by mapping all possible uncertain net present value outcomes of a project.¹² They noted that while traditional sensitivity analysis and scenario analysis can also be used to perform the same analysis,

neither technique allows the user to examine the probabilities of a capital project's success.

In contrast, simulation overcomes these limitations by examining the effects of all combinations of variables and their realizations. The authors further illustrated these issues using a real-life simulation problem and concluded that simulation helps management accountants make better decisions because it “examines the effects of all possible combinations of variables and lets managers better understand and visualize risk and uncertainty.”

Thomas L. Zeller, Brian B. Stanko, and Andrew D. Tressler examined how management accountants can conduct risk analysis for lease vs. buy decisions for fixed assets and suggested that simulation can make the risk in a lease vs. buy decision explicit because it presents all possible outcomes.¹³ By using a variety of real-life examples, they highlighted that using the simulation approach is an effective way for “management accountants to add value to the decision process and manage constituents’ expectations” because they can provide “considerable insight to the decision-making process by approximating the risk of one option over another.”

EXERCISE IMPLEMENTATION

Before implementing the exercise in class, students will read two articles as background material. The first article by Clark, Reed, and Stephan discusses how to use simulation in a capital budgeting project, while the second article by Zeller, Stanko, and Tressler discusses how management accountants can use simulation to help managers make lease vs. buy decisions in relation to fixed assets. Overall, this pre-class reading should equip students with a contextual understanding of how simulation helps solve problems in management accounting. Once students have gone through this background material, the exercise takes 90 minutes in class. Figure 1 presents the three-phase process in implementing the exercise.

At the end of this exercise, students should understand the simulation technique and how to use it to address management accounting problems. They should also be able to apply the four steps in developing simulation models in Excel (introduced in phase 2) to solve management accounting problems.

Phase 1: Introduction to Simulation

Phase 1 introduces the class to simulation and should take approximately 20 minutes. Through the introduction, students should understand that simulation is a mathematical technique to solve problems by performing a large number of trial runs called simulations and inferring a solution from the collective results of the trial runs.

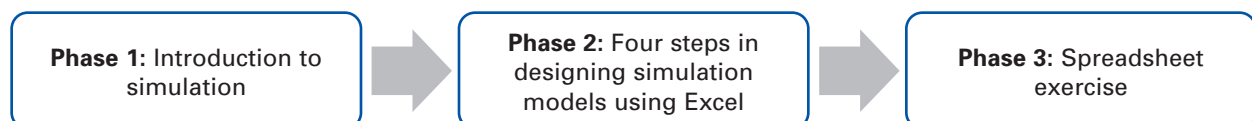
In addition, students should also appreciate how simulation can help accountants make decisions under conditions of uncertainty across a range of functional areas, including financial accounting, management accounting, and audit.

Phase 2: Four Steps to Develop Simulation Models

Phase 2 introduces students to a four-step process to develop simulation models using Excel and should take approximately 20 minutes. The four-step process includes the following:

1. *Design an appropriate spreadsheet model.* This requires students to develop an appropriate spreadsheet model that includes formulas to relate output cells to input cells, a method to enter random number generator (RNG) formulas into input cells, and the ability to make the spreadsheet recalculate many times and capture the resulting output for statistical analysis.¹⁴
2. *Insert RNG formulas into input cells whose outcome values are uncertain.* Each time the Excel model performs a recalculation, an RNG formula will generate a random outcome value, drawn from a predefined distribution of values, which mimic actual outcomes.

Figure 1: Three-Phase Implementation Guide for the Simulation Exercise



3. *Repeat the simulation.* The exercise involves using the data table function in Excel to “trick” the spreadsheet (i.e., it uses the data table in an unconventional manner) to perform recalculations and record the output values from each recalculation.¹⁵
4. *Analyze the output and make decisions.* Finally, analyze the output from the previous step and use that information to make informed decisions. The appendix presents accompanying slides for phases 1 and 2 of the class.¹⁶

Phase 3: Solving the Simulation Problem

In Phase 3, instructors provide a simulation problem on making revenue projections and guide students to solve the problem by building a simulation model in Excel. Phase 3 should take approximately 50 minutes. Here is the simulation problem:

You are the CFO of Riverside Coffee, a coffee chain with more than 30 outlets. The company has recently launched a new coffee drink—the Ice-blended Latte—which it hopes will be popular with younger customers. To generate demand for the drink, your company has invested in an elaborate marketing campaign that

will continue until the end of the year.

The drink has been priced at \$6.50 per cup. At this price, you expect demand for the drink to be random (i.e., subject to uncertainty) but to follow a normal distribution that displays the following characteristics each month (see Table 1).

Required

Develop a simulation model in Excel to help you:

1. Measure and describe characteristics of expected sales revenue.
2. Determine the probability that sales revenue will exceed \$150,000 from August to December.
3. Determine the 95% confidence interval for the population mean of sales revenue from August to December.

Designing an Appropriate Spreadsheet Model

To solve the problem, we apply the four-step process in phase 2. Figure 2 presents the spreadsheet model in Excel.

Cells B2:G5 reproduce the characteristics of the normal distributions that demand for the drink is expected to follow from August to December, as the

Table 1: Distribution of Ice-Blended Latte

	August	September	October	November	December
Mean	3,500	4,000	4,500	5,000	7,500
Standard deviation	300	320	430	510	800

Figure 2: Simulation Spreadsheet Model

	A	B	C	D	E	F	G
1							
2		Demand Information					
3			August	September	October	November	December
4		Mean Demand	3500	4000	4500	5000	7500
5		Standard Deviation of Demand	300	320	430	510	800
6							
7							
8							
9		Revenue					
10			August	September	October	November	December
11		Demand	2,829	4,284	4,700	5,139	7,988
12		Sale Price	\$6.50	\$6.50	\$6.50	\$6.50	\$6.50
13		Revenue	\$18,388.50	\$27,846.00	\$30,550.00	\$33,403.50	\$51,922.00
14							
15						Total Revenue	162,110.00

problem provided. Cells B9:G15 compute the total sales revenue expected from the drink from August to December. In particular, we take the following steps in the Excel spreadsheet:

- Demand: Copy and paste the mean monthly demand from cells C4:G4 into cells C11:G11.
- Sales price: Insert the sales price of \$6.50 into cells C12:G12.
- Revenue: Insert the formula $=C11*C12$ into cell C13 to compute the revenue for August and then copy this formula to D13:G13 to compute the revenue from September to December.
- Total revenue: Insert the formula $=SUM(C13:G13)$ into cell G15 to compute the total revenue from August to December. This represents the output from the model.

Inserting RNG Formulas

In this problem, the actual monthly demand for the drink is subject to uncertainty. As stated in the problem, the company expects monthly demand to be random but to follow a given normal distribution (i.e., while the problem tells us that demand is likely to follow a normal distribution, we do not know for sure what actual demand is going to be each month). Accordingly, we modify our spreadsheet model by inserting RNG formulas into the following cells representing uncertain monthly demand:

- Demand: In cell C11, replace the original value with the RNG formula $=ROUND(NORM.INV(RAND(),C4,C5),0)$.¹⁷ Copy this formula to cells D11:G11 to insert the corresponding RNG formulas into cells representing demand from September to December.

Repeating the Simulation

In the third step, we repeat the simulation 1,000 times using a data table. The data table is represented in cells A21:B1021 and is linked to the output cell (i.e., cell G15) of our spreadsheet model in cell B21 using a formula. Specifically, the formula $=G15$ is inserted in cell B21. Figure 3 presents the data table parameter menu in Excel, while Figure 4 presents a portion of the repeated simulations we carried out in our model.

In the data table parameter menu, we designate cell

A19 as the column input cell. Accordingly, the data table will cause the Excel spreadsheet to recalculate 1,000 times and record each corresponding revenue amount from the model output cell (i.e., cell G15) in column B of the data table (i.e., cells B22:B1021).

Figure 3: Data Table Parameter Menu

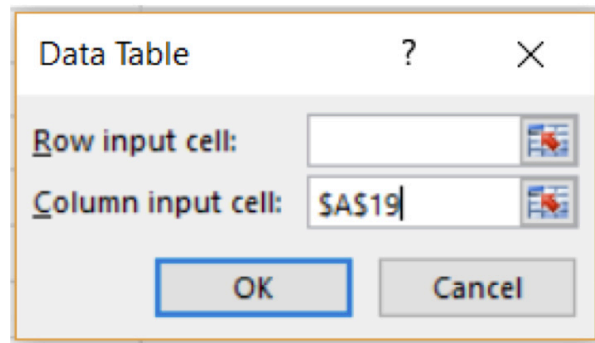


Figure 4: Portion of Repeated Simulations in Excel Model

	A	B
16		
17		
18	1000 Replications	
19		
20	Total Revenue	
21		\$162,110.00
22	1	\$168,213.50
23	2	\$174,473.00
24	3	\$169,338.00
25	4	\$153,842.00
26	5	\$156,617.50
27	6	\$168,051.00
28	7	\$159,477.50
29	8	\$159,087.50
30	9	\$162,513.00
31	10	\$145,229.50
32	11	\$147,504.50
33	12	\$154,290.50
34	13	\$156,195.00
35	14	\$161,232.50
36	15	\$155,507.00

Figure 5: Summary Statistics for 1,000 Repeated Simulations in Excel Model

	D	E	F
16			
17			
18		(a)	
19		Parameters	
20		Mean	\$159,370.99
21		Standard Deviation	\$7,069.19
22		Min	\$137,280.00
23		Max	\$182,221.00
24		Range	\$44,941.00
25			
26		(b)	
27		Count of >\$150,000	914
28		Count of number of simulations	1001
29		Probability of >\$150,000	0.91
30			

Analyzing the Output and Making Informed

Decisions

The problem requires students to:

1. Measure and describe characteristics of expected sales revenue.
2. Determine the probability that sales revenue will exceed \$150,000 from August to December.
3. Determine the 95% confidence interval for the population mean of sales revenue from August to December (see Figure 5).

We perform the analysis to measure and describe characteristics of sales revenue in cells E18:F24 where we compute the mean, standard deviation, minimum, maximum, and range of the 1,000 simulations obtained. To do so, we insert the following formulas into the Excel spreadsheet:

- Mean: Insert the formula **=AVERAGE(B21:B1021)** into cell F20.
- Standard deviation: Insert the formula **=STDEV.S(B21:B1021)** into cell F21.
- Minimum: Insert the formula **=MIN(B21:B1021)** into cell F22.
- Maximum: Insert the formula **=MAX(B21:B1021)** into cell F23.
- Range: Insert the formula **=F23-F22** into cell F24.

We perform the analysis to determine the probability that sales revenue will exceed \$150,000 in cells

E26:F29. To do so, we take the following steps.

- Count of >\$150,000: Insert the formula **=COUNTIF(B21:B1021,">150000")** into cell F27. This counts the number of simulations that result in revenues of more than \$150,000 recorded.
- Count of number of simulations: Insert the formula **=COUNT(B21:B1021)** into cell F28. This counts the number of simulations performed.
- Probability of >\$150,000: Insert the formula **=F27/F28** into cell F29. This computes the probability that total revenue from August to December will exceed \$150,000.

We perform the analysis to determine the 95% confidence interval for the population mean in cells E31:F33 by doing the following:

- 95% lower confidence limit: Insert the formula **=F20-(CONFIDENCE(0.05,F21,F28))** into cell F32. This computes the lower limit of the 95% confidence interval of the population mean.
- 95% upper confidence limit: Insert **=F20+(CONFIDENCE(0.05,F21,F28))** into cell F33. This computes the upper limit of the 95% confidence interval of the population mean.¹⁸

Overall, the previous information will provide students with relevant information relating to the expected sales revenue from launching the new drink.

FINAL THOUGHTS

In this article, we introduced an Excel exercise on simulation and highlighted how instructors can use a three-step implementation process to implement the exercise in a management accounting class. The literature highlights how accountants often make decisions under conditions of uncertainty in functional areas of accounting that include financial accounting, management accounting, and audit. In this respect, simulation is a data analytics technique that accountants can use to improve decision making. By highlighting how to build simulation models using Excel to solve a management accounting problem, our article identifies an important data analytics skill set and provides guidance on how to implement it into the accounting curriculum. ■

Clarence Goh, Ph.D., CA (Singapore) is an assistant professor of accounting (practice) at Singapore Management University. He can be reached at clarencegeh@smu.edu.sg or (65) 6828-1931.

Poh-Sun Seow, Ph.D., FCA (Singapore), is an associate professor of accounting (education) at Singapore Management University. He can be reached at psseow@smu.edu.sg or (65) 6828-0935.

Gary Pan, Ph.D., FCA (Singapore), is a professor of accounting (education) at Singapore Management University. He can be reached at garypan@smu.edu.sg or (65) 6828-0983.

ENDNOTES

- 1 Norbert Tschakert, Julia Kokina, Stephen Kozlowski, and Miklos Vasarhelyi, "The Next Frontier in Data Analytics," *Journal of Accountancy*, August 2016, pp. 58-63.
- 2 Sarah Ovaska-Few, "Prepare accounting students for working with data analytics," *Journal of Accountancy*, December 12, 2017, bit.ly/3yVntqx.
- 3 Clarence Goh, Gary Pan, Poh Sun Seow, Benjamin Lee, and Melvin Yong, *Charting the Future of Accountancy with AI*, CPA Australia, Singapore, 2019; Gary Pan, Poh Sun Seow, Clarence Goh, and Melvin Yong, *Riding the Waves of Disruption*, CPA Australia, Singapore, 2017.
- 4 Lorraine Lee, William Kerler, and Daniel Ivancevich, "Beyond Excel: Software Tools and the Accounting Curriculum," *AIS Educator Journal*, January 2018, pp. 44-61.
- 5 Usha Ramachandran Rackliffe and Linda Ragland, "Excel in the Accounting Curriculum: Perceptions from Accounting Professors," *Accounting Education*, February 2016, pp. 139-166.
- 6 Wendy Tietz, Jennifer M. Cainas, and Tracie L. Miller-Nobles, "Excel: The Common Denominator," *Strategic Finance*, August 2021, bit.ly/2X8MTne.
- 7 Veronda F. Willis, "A Model for Teaching Technology: Using Excel in an Accounting Information System Course," *Journal of Accounting Education*, September 2016, pp. 97-99.
- 8 David E. Stout, "Regression Analysis: Instructional Resource for Cost/Managerial Accounting," *Accounting Education*, January 2015, pp. 57-73.
- 9 Dmitry Pugachevsky, Rohan Douglas, and Roman Bedau, "IFRS 13—Accounting for CVA & DVA," *Global Capital*, September 2014.
- 10 Kian Hui Ng and Elisa Noble, "Audit of Share-based Payments," *IS Chartered Accountant*, July 2015, bit.ly/3yXF3u9.
- 11 Pugachevsky, et al., 2014.
- 12 Virginia Clark, Margaret Reed, and Jens Stephan, "Using Monte Carlo Simulation for a Capital Budgeting Project," *Management Accounting Quarterly*, Fall 2010, pp. 20-31.
- 13 Thomas L. Zeller, Brian B. Stanko, and Andrew D. Tressler, "How Risky Are Your Lease vs. Buy Decisions?" *Management Accounting Quarterly*, Fall 2015, pp. 9-18.
- 14 In addition, students should also be encouraged to incorporate fundamental good design practices, which apply generally to all spreadsheet models, when designing their simulation models. Cynthia Frownfelter-Lohrke, "Teaching Good Excel Design and Skills: A Three Spreadsheet Assignment Project," *Journal of Accounting Education*, June 2017, pp. 68-83.
- 15 Chengping Zhang, "Incorporating Powerful Excel Tools into Finance Teaching," *Journal of Finance Education*, Fall/Winter 2014, pp. 87-113.
- 16 Where appropriate, these slides may also be assigned to students as pre-readings before class.
- 17 The NORM.INV function generates random values from a normal distribution with a mean of 3,500 and a standard deviation of 300. The ROUND function rounds the value to the nearest integer, reflecting the fact that the demand for drinks should be represented as integers. This RNG formula explicitly incorporates the uncertainty associated with the demand for drinks into the Excel model, hence driving the total revenue amount that is computed in cell G15 and, consequently, the 1,000 amounts obtained when repeating the simulation.
- 18 A confidence interval gives an estimated range of values that is likely to include an unknown population parameter, the estimated range being calculated from a given set of sample data. The 95% confidence level in the problem refers to the percentage of probability, or certainty, that the confidence interval would contain the true population mean. The confidence function used in the problem returns the confidence interval of our population mean. Adding (subtracting) the confidence interval to (from) our sample mean computes the upper (lower) limit of the 95% confidence interval. Valerie J. Easton and John H. McColl, *Statistics Glossary*, September 1997, bit.ly/3BRtID4.

Introduction to Simulation

Simulation

- A technique that measures and describes various characteristics of the base line performance measure of a model when one or more values for the independent variable are uncertain
- The objective of simulation is to describe the distribution and characteristics of the possible values of the bottom line performance measure given the possible values and behavior of the input variables

Four steps in simulation using spreadsheets

- Step 1: Develop spreadsheet model
- Step 2: Insert appropriate random number generators (RNGs)
- Step 3: Repeat simulations
- Step 4: Analyze output, make decisions

Benefits of simulation

- We have more insights with simulation
 - Best/worst case
 - Mean
 - Distribution and variability
 - Solid empirical evidence to support our assertions or recommendations

Step 1: Develop spreadsheet model

- Basic elements of the spreadsheet model
 - Formulas for relating output cells to input cells
 - A method for entering RNGs into input cells
 - The ability to make the spreadsheet recalculate many times and capture the resulting output for statistical analysis

Step 2: Insert appropriate RNGs

- RNGs explicitly model uncertainty in the spreadsheet models
- Each time the spreadsheet recalculates, RNGs generate (new) random value in input cells, which in turn produce new output values

Step 3: Repeat simulation

- Data table allows Excel to repeat the simulation in the Excel model

Step 4: Analyze output, make decisions

- Data analysis
 - Descriptive statistics (mean, standard deviation, etc.)
 - Probabilities
 - Confidence intervals