

CFE SDM Model Solutions

Spring 2024

1. Learning Objectives:

1. The candidate will understand and apply strategic management concepts and frameworks to develop an organization's financial and ERM Solutions.

Sources:

Strategic Management – Ch. 6: Corporate-Level Strategy

Corporate Valuation, Measuring and Managing the Value of Companies – Ch. 18: Using Multiples & Ch. 38: Banks

Commentary on Question:

This question tests the candidate's understanding of banks, various metric calculations, management actions, and the ability to evaluate these concepts regarding Big Ben. Overall, there was mixed performance on the various pieces of the question.

Solution:

- (a) Describe the three types of income that Big Ben generates.

Commentary on Question:

Overall, most candidates were able to identify the three types of income. However, some candidates lost points for not providing adequate descriptions.

Interest income

The difference between the interest income that the bank earns from lending and the interest expense it pays to borrow its funds is its net interest income.

Fees and commissions income

Bank charges fees and commissions for services such as transaction advisory, managing investment assets, and securities brokerage.

Trading income

These are profits generated by trading a wide variety of products including but not limited to stocks, bonds, foreign exchange, credit default swaps and asset backed debt obligations.

1. Continued

- (b)
 - (i) Explain why equity discounted cashflows (equity DCF) is an appropriate valuation method for Big Ben. Justify your answer.
 - (ii) Explain three pitfalls of equity DCF valuation.

Commentary on Question:

To receive marks for part b, candidates needed to provide responses based on the source materials. Several candidates recalled the information very well, while many received partial marks for inadequate explanations or generic responses not found in source materials.

- (i) Unlike non-financial companies, operating and financing decisions for banks are the same because interest income and expense decisions are the main operations of a bank. This is why equity DCF model is better to value banks because it accounts for both operational and financial CFs.
- (ii) The 3 pitfalls are the following:

Source of value creation.

The equity DCF model doesn't tell whether the bank is creating or destroying value.

Impact of leverage and business risk on cost of equity.

Equity DCF assumes constant cost of equity which is not accurate. If bank decreases equity risk capital, the return on equity goes up but it shouldn't result in higher bank value. This is because the CFs are now riskier so cost of equity should change as well.

Tax penalty on holding equity risk capital.

How the bank is funding its capital, i.e., via debt or equity will have an impact on cost of equity. If the bank funds through equity, it will be paying taxes on interest income vs dividend payments on debts are tax deductible.

- (c)
 - (i) Critique the use of Price-to-Earnings as a metric for comparing the value of financial institutions.
 - (ii) Recommend a more appropriate ratio for comparing the value of financial institutions. Justify your answer.

1. Continued

Commentary on Question:

Answering part (i), candidates needed to mention that P/E does not account for the capital structure/makeup of companies. Part (ii), only one of the two ratios listed below was needed. Several candidates answered this question well, but many received only partial points. Some candidates made up their own ratio of different values in part (ii) instead of using one from the source materials or did not provide sufficient justification.

- (i) Pro: P/E is easy to calculate, compare and widely used by analysts.
Con: Low P/E can indicate that a company is trading at a discount, but it should be investigated further because P/E does not account for capital makeup of companies.
 - (ii) I would recommend Net Enterprise value to EBITA (Earnings before income, tax, and amortization) or Net Enterprise value to NOPAT (Net operating profit after tax). These ratios are better because they account for the distorting effects of capital structure, non-operating assets, and non-operating income statement items such as non-operating portion of pension expense.
- (d) Assume that Big Ben's growth rate, as defined for equity DCF, will be 3.5% every year after the year 2027.
- (i) Calculate the value of the commercial banking business equity using an equity DCF model as of January 1, 2024. Show your work.
 - (ii) Recommend whether Big Ben should decrease its commercial banking operations. Justify your answer.

Commentary on Question:

Many candidates were able to correctly calculate the net income, cash flow to equity, and return on equity components, though several missed deducting income tax in the net income calculation. Candidates struggled with calculating the continuing value, however, and thus did not get the correct value of the commercial banking business equity. Most candidates identified in part (ii) that the commercial banking operations should not be decreased, but some lost points due to inadequate justification.

1. Continued

- (i) *See Excel Solution for Work.*
Value of Commercial Banking Equity = 5,982.6.
- (ii) Big Ben should not decrease its commercial banking operations because it is creating value. This is supported by the return on equity of 11%. The market to book value is also positive. Big Ben should compare this return with ROE from other businesses. Another way to measure the value that commercial banking is creating is to do Multiple Analysis where Big Ben's multiples can be compared with other similar business. The asset management business multiples should not directly be compared to commercial business because they are different business. Care must be taken to choose the right subset of companies to compare the commercial business multiples against.
- (e) Calculate the economic spread on the loans and on the deposits for the commercial banking business for the year 2024. Show your work.

Commentary on Question:

Overall, the candidates did well on this question. Many candidates provided results on a pre-tax basis but received points as the question did not specify calculating answers pre- or post-tax.

See Excel Solution for Work.

Economic Spread on Loans at 2024 = 99.6

Economic Spread on Deposits at 2024 = -7.8

- (f)
 - (i) Calculate the Matched Capital Charge for Big Ben's commercial banking business for 2024. Show your work.
 - (ii) Calculate the Mismatched Capital Charge for Big Ben's commercial banking business for 2024. Show your work.
 - (iii) Explain what the Matched and Mismatched Capital Charges for Big Ben's commercial banking business indicate about the value created for Big Ben.

Commentary on Question:

Several candidates were able to calculate the mismatched capital charge correctly. A few mixed up matched vs. mismatched capital charges. Most candidates struggled with calculating the matched capital charge and providing an adequate explanation of these capital charges and the value they indicate for Big Ben.

1. Continued

- (i) *See Excel Solution for Work.*
Matched Capital Charge at 2024 = 82.5
- (ii) *See Excel Solution for Work.*
Mismatched Capital Charge at 2024 = 65.0
- (iii) 82.5 is the matched capital charge. Matched capital charge is the return required on assets and liabilities if there was no maturity mismatch and no economic spread, so no special value created by the bank. The shareholders are putting up equity and are compensated for their equity at the Matched Opportunity Rate of the deposits. The calculation is $(\text{Loans} - \text{Deposits}) * \text{Matched Opportunity Rate of the deposits}$.

65 is the mismatched capital charge. Mismatched capital charge is the return that the bank makes due to the difference in duration between bank's assets and deposits. The bank is taking a risk by holding positions on different parts of the yield curve and so this capital charge is compensating the shareholders for that risk. This item does not demonstrate inherent value that the bank is creating. The calculation is $\text{Loans} * (\text{Matched opportunity rate of loans} - \text{Matched opportunity rate of deposits})$.

- (g)
 - (i) Critique your colleague's recommendation.
 - (ii) Recommend an alternative metric. Justify your answer.

Commentary on Question:

Most candidates identified that growth in interest income does not consider riskiness or could encourage riskier loans. Few recognized that it is not a good indicator of overall profitability. Alternative metrics differing from total economic spread were accepted for part (ii) if reasonable, but many candidates lost points due to insufficient justification.

- (i) Growth in interest income does incentivize employees to grow the loan book; however, it does not consider the riskiness of business nor overall profitability.
- (ii) I recommend using total economic spread. This metric tracks growth of the block in absolute terms, addresses profitability, considers riskiness, and would require minimum and maximum targets.

1. Continued

- (h)
 - (i) Explain the diversification strategy being proposed.
 - (ii) Explain how this diversification strategy can be value-creating.
 - (iii) Explain a potential risk of using a common customer service software. Justify your response.

Commentary on Question:

Some candidates correctly identified the diversification strategy, while some did not. Most were able to explain that this would create cost savings/economies of scope. Other potential risks were accepted if reasonable and sufficiently justified.

- (i) Related constrained – this diversification strategy is sharing technology (resource) for customer service (operations).
 - (ii) Economies of scope can create cost savings. In this case, sharing contact center software (resource) is reducing the overall cost.
 - (iii) Resource sharing requires careful coordination between the two departments. In this case, there could be limited resources to manage the software so there can be challenges in prioritizing support for the software to the benefit of either Big Ben or Darwin Life.
- (i)
 - (i) Describe how to transfer a core competency.
 - (ii) Explain two ways value is created for Darwin by transferring the marketing core competency from Big Ben.
 - (iii) Explain two potential pitfalls in transferring Big Ben’s marketing core competency to Darwin.

Commentary on Question:

Overall candidates did well on this question. Some candidates received partial credit instead of full marks as they only provided one way to transfer a core competency or did not provide two distinct ways value is created/two distinct pitfalls in (ii) and (iii) – e.g., providing both responses to part (ii) related to competitive advantage or both responses in part (iii) related to integration issues instead of providing two distinct responses on each. Other pitfalls than the ones listed below were accepted if reasonable and sufficiently explained.

1. Continued

- (i) To transfer a core competency, the company can transfer staff with key knowledge (such as managers), the firm with the core competency completes work on behalf of another (outsourcing), or the knowledge can be transferred via training meetings, discussions, etc.
- (ii) The expense of developing (or outsourcing) a core competency in marketing has been already incurred by Big Ben, therefore it eliminates the need for Darwin to allocate resources to develop it.

Additionally, the recognized industry-wide marketing expertise of Big Ben is an intangible resource and is hard for Darwin's competitors to understand and imitate. By transferring this competency, Darwin should gain an immediate competitive advantage over its rival.

- (iii) Transferring managerial resources might be challenging as the manager at Big Ben might be reluctant to transfer key people. Furthermore, these key people might not want to transfer over. If it requires transferring technological knowledge, differences in how the business operates can increase integration costs.

Second, there can be managerial motives at Big Ben to diversify their marketing competency such as increased compensation and reduced managerial risk. This can be value reducing if sufficient controls are not in place to limit managerial tendencies to over diversify.

2. Learning Objectives:

1. The candidate will understand and apply strategic management concepts and frameworks to develop an organization's financial and ERM Solutions.
4. The candidate will be able to analyze and model dynamic systems and evaluate the risks and sustainability of these complex systems.

Learning Outcomes:

- (1a) Evaluate and apply strategic management concepts, recognizing factors that affect development and implementation of strategies:
- Analyze the firm's external environment and the internal organization.
 - Describe and apply strategic management models, including Porter's five forces and value chain analysis.
 - Define types of business-level strategies and recommend an appropriate business-level strategy for a given situation.
- (4b) Explain the underlying factors that drive the sustainability and stability of a dynamic system:
- Evaluate the structure and behavior of dynamic systems
 - Identify the factors that contribute to risk and instability in dynamic systems
- (4c) Evaluate complex systems and describe how actuarial principles can mitigate risks and improve sustainability.

Sources:

Business Dynamics Steman: Chapter 4 Structure and Behavior of Dynamic Systems

Business Dynamics Steman: Chapter 5 Causal Loop Diagrams

Business Dynamics Steman: Chapter 17 Supply Chain and Origin of Oscillations

Understanding Porter Part 1: Chapters 1-3

Cultural Change that Sticks

Commentary on Question:

This question attempted to test candidates' knowledge of dynamic systems and their applications to inventory and revenue in the context of oscillations. Candidates received partial credit on many of the parts, but in general, struggled to demonstrate enough knowledge for full credit. Specific commentary will be provided by part below.

2. Continued

Solution:

(a)

- (i) Define “oscillation” as a mode of behavior in a dynamic system.
- (ii) State the equilibrium condition for inventory.

Commentary on Question:

This was a direct recall question. Candidates did well on part (i), but had trouble fully articulating the equilibrium condition for inventory. Many candidates received partial credit.

- (i) Oscillations are characterized by continuous cycle of overshooting the equilibrium state, reversing, undershooting, etc. The dynamic behavior is usually driven by a negative feedback loop with delays.
- (ii) The equilibrium condition for inventor is Production = Shipments. Therefore, the stock of inventory will reach balance only when

$$\text{Production} = \frac{(\text{Desired Inventory} - \text{Inventory})}{\text{Inventory Adjustment Time}} = \text{Shipments}$$

or when

$$\text{Inventory} = \text{Desired Inventory} - \text{Shipments} * \text{Inventory Adjustment Time}$$

(b)

- (i) Identify four factors that may affect the oscillation of BJT’s revenue. Justify your answer.
- (ii) Explain how each of the factors identified in part (i) affects the North American tire industry using Porter’s Five Forces. Justify your answer.

Commentary on Question:

Candidates struggled with part (i) to identify factors that would truly cause oscillations in revenue. Many candidates identified factors that would affect revenue, but the impacts would be one-time, like in the case of a tire recall, or would affect revenue indirectly, like labor strikes (which increase expenses, which would likely flow through to prices, which could ultimately impact revenue). Candidates’ justifications tended to only focus on the first order impact and did not often connect the impact to oscillations (repeated increases and decreases).

2. Continued

Other candidates generically talked about changes in demand as something that could affect revenue. These candidates failed to identify what factor would affect demand (which would then affect revenue).

Most candidates received partial credit for at least identifying factors and providing some justification for those factors affecting revenue. Well prepared candidates identified factors external to BJT, making their job easier on part (ii) since the Porter's Five Forces are related to an industry (rather than a single firm)

On part (ii) some candidates discussed all five forces in relation to each of the four factors from (i). Most candidates picked one or two forces and justified their choices. Both approaches could have received full credit.

Many candidates missed out on points arguing the buying power of buyers would increase when the buyer was either individual customers or one of BJT's distributors. In this instance individual customers have no power and their buying power of tires was not likely to increase in any circumstance. Similarly, BJT's buyers as distributors are very dispersed, with the largest buyer being 5% of BJT's revenues. These buyers were similarly not likely to see their buying power increase.

The most common forces receiving full marks were Buying Power of Suppliers (of rubber or labor), Threat of New Entrants, and Intensity of Rivalry Among Existing Competitors.

Threat of Substitutes was attempted in the context of synthetic rubber or buying fewer cars (using more public transportation), but these threats are not particularly strong.

Factors and justifications that received full credit included:

Part i)

- Factor: The availability of rubber / global supply chain risk.
 - Justification: The case study indicates that part of the world is still experiencing disruptions due to COVID, causing supply chain issues. The industry is having difficulty acquiring materials for tire production. When rubber is unavailable or delivered late, it could cause revenues to decrease. When rubber is available and delivered timely and predictably, revenues return to prior levels (often after a delay).

2. Continued

- Factor: The price of rubber / commodity risk
 - Justification: as the price of rubber fluctuates, potentially driven by supply chain issues (as described above), the price of tires can fluctuate. As the price of tires increases, customers will demand less. Given price inelasticity, the decrease in demand usually offsets the increase in price, causing revenues to decrease, and vice versa, so as the price of rubber varies so too would BJT's revenues (with delays).
- Factor: The price of oil (another commodity risk) or the demand for travel (both would be valid and the justifications are similar)
 - Justification: the case study indicates that increasing oil prices has been a negative for the tire industry and that the demand for travel has increased dramatically. To the degree consumers buy more cars/demand more tires, revenues would increase and vice versa.
- Factor: new, lower cost international competitors entering the market
 - Justification: The case study mentions these competitors have been entering the lucrative North American market and that they may have access to cheaper rubber with fewer supply chain issues. The increased competition could steal market share from BJT, decreasing revenue. BJT's management would likely respond, fighting to regain or further grow market share, regaining lost revenues. And so on.

Part ii)

- Factor: The availability of rubber / global supply chain risk.
 - Porter's Five Forces: this factor would increase the buying power of suppliers as they would have more control over the price. The threat of substituting to synthetic rubber is relatively low (only 15% of BJT's rubber is synthetic), reinforcing the suppliers power.
- Factor: The price of rubber / commodity risk
 - Porter's Five Forces: similar to the above, the buying power of suppliers with a discussion of threat of substitutes would receive full marks. Candidates could argue the rivalry among competitors would increase as they're all fighting for limited supply. Or that the threat of new entrants might decrease given the limited access to rubber.
- Factor: The price of oil (another commodity risk) or the demand for travel (both would be valid and the justifications are similar)
 - Porter's Five Forces: threat of new entrants or the rivalry of existing competition might both increase because of these changes in external prices/demands. A discussion of the threat of substitutes would need to reflect the possibility—but low likelihood—of change, but this would not be a driving force.

2. Continued

- Factor: new, lower cost international competitors entering the market.
 - Porter's Five Forces: threat of new entrants. Candidates would not need much discussion for full marks on this one.

(c) Explain the feedback loop created by the addition of this node.

Commentary on Question:

Well prepared candidates described a new, full feedback loop, usually starting with orders, leading to an increase in tires replaced in the warranty program, leading to a drawdown of inventory. Other loops were also given credit if fully justified and the polarity accurately articulated.

Many candidates simply described influences on the system, rather than describing a new loop. For example, arguing that the warranty program would increase the desirability of the product. While this is true, this is more of an externality to the system driven by the existence of the warranty program, not the source of a loop driven by tires actually replaced in the warranty program. Some of these candidates did note how the influences would flow around the existing loops but did not describe a new loop.

The new loop would begin with increases in orders leading to an increase in tires replaced in the warranty program. These tires must come from somewhere, so the increase must either increase the backlog of unfilled orders or decrease inventory.

If the tires loop back to unfilled orders that would be a positive loop as both parts of the loop have positive impact.

It feels more natural that the tires replaced under warranty would draw from and decrease inventory. In this case, the loop would be a balancing loop with one positive arm and one negative for a net negative loop polarity.

(d) Critique BJT management's plan to grow inventories with respect to BJT's Risk Profile.

Commentary on Question:

Most candidates struggled with this question. The question was aimed at the pros and cons of having more inventory and the timeframe within which that inventory was acquired, looking for considerations in the context of a stock and flow model and how BJT's risk profile relate to those considerations. Most candidates focused on the risks of production/manufacturing and the labor required to produce the inventory (without discussing inventory). Other candidates critiqued the already-executed plan of acquiring and refitting the new plant; it's not a plan if it's done.

2. Continued

As a critique question, very few candidates mentioned a valid pro of the plan beyond that it could help meet the increase in demand or that it was intendedly rationale, which while true, bore no relation to the inventory context of the question.

Management's plan to grow inventories in response to increased demand has some pros and cons that may present themselves in various circumstances.

Management may not need to increase inventory to meet demand if production can fully keep up with new orders, as seems to be the intent of buying and refitting a new plant. In this case, the additional inventory may just be an added expense (of holding and storing the unneeded inventory).

To increase the stock of inventory, BJT will need to increase its acquisition rate of rubber. This could exacerbate the Commodity and Global Supply Chain Risks as the amplification rate would require a greater than 50% increase in the acquisition of rubber. The difference in timing (two years on the increase in demand vs. 18 months on the increase in inventory) could make this problem even worse. Similarly, BJT could be subject to exchange rate risk to the degree their Canadian operations is storing additional inventory and the conversion rate moves unfavorably.

Once the inventory was acquired, BJT would be insulated from Commodity risk and Global Supply Chain issues that may cause production decreases or tire price increases. Instead of increasing prices, BJT could temporarily decrease production and release inventories, limiting any impacts on BJT's customers. BJT could then rebuild inventories when rubber prices stabilized. BJT might also be able to release inventories in Canada when exchange rates are unfavorable and rebuild them when rates were more favorable (although management should probably seek to hedge this risk rather than use inventory levels to manage it).

Should the additional tires not be needed, either because production keeps up with demand or the demand falls, there may be addition environmental risk if the extra inventory needs to be discarded. BJT's recycling process would likely be sufficient given the low risk.

- (e) Explain how oscillation is exhibited by a system with a steady state error.

Commentary on Question:

Well prepared candidates gave a definition of a system with a steady state error (SSE) that included the element of time, and described how the that type of system might occur. Candidates received partial credit for partial definitions. Many candidates failed to adequately describe how oscillations would be exhibited in such a system given the definition.

2. Continued

A steady state error (SSE) means a gap exists between the desired and actual states and the gap persists even after the system has had time to settle into a steady state. This SSE might arise from omitting replacement of expected loss from models or may be caused when a firm sets production targets based only on gaps between desired and actual inventories.

Oscillations may rise as follows:

- Management observes a gap (e.g. actual inventories lower than desired inventories)
- Management takes corrective action (e.g. orders more production)
- Prior decreases in loss rates (e.g. reduced orders in the slow season) were not recognized, so inventories were replenished by existing production.
- The increase production over filled inventories beyond desired inventories (back to management observes a gap).

- (f) Critique BJT management's plan to grow inventories with respect to inventory stability.

Commentary on Question:

Most candidates failed to realize that stability has a formal definition, akin to equilibrium from part a (ii), where the loss rate and order rate are equal. As a result, many candidates gave vague responses hinting at how certain things might stabilize inventory. Well-prepared candidates discussed inventory stability in the context of whether the long-term demand expectations were realized or not.

Similar to question d, few candidates gave adequate pros of management's plan within the context of inventory stability as indicated by the Critique verb.

Stability is created when the Loss Rate and Acquisition Rate are equal. In anticipation of an increase in the future loss rate, BJT's management is suggesting to increase the desired acquisition rate faster than the increase in future loss rate.

If management's demand expectations are realized, this plan can contribute to inventory stability to the extent production (acquisition) can keep up with shipments (orders/losses). If management's demand expectations are not realized, BJT may need to significantly reduce their acquisition rate and release inventories or bear the cost of holding inventories hoping demand eventually improves.

BJT's management plan to increase inventories may not be needed. For example, management may not need to increase inventory to meet demand if production can fully keep up with new orders, as seems to be the intent of buying and refitting a new plant. In this case, the additional inventory may just be an added expense (of holding and storing the unneeded inventory).

2. Continued

Furthermore, maintaining a stable inventory may not always be desired, for example in the face of external factors like commodity risk and global supply chain issues. Once the inventory was acquired, BJT would be insulated from issues that may cause unexpected production decreases (acquisition rate decreases) or tire price increases (changing orders). Instead of increasing prices, BJT could temporarily decrease production and release inventories, limiting any impacts on BJT's customers. BJT could then rebuild inventories when rubber prices stabilized. In this case, BJT would be sacrificing inventory stability to mitigate other risks.

- (g) Your colleague states that once tire inventory levels have reached the desired level, revenues will oscillate less.

Critique your colleague's statement.

Commentary on Question:

This was another critique statement. Candidates more consistently gave positive and contextually accurate evaluations of the statement than on the prior questions. Many candidates acknowledged that getting rid of oscillations may never occur, but failed to describe that with higher inventories revenues could oscillate more in certain cases. The distinction between inventory levels and revenue oscillations and their cause-and-effect relationships was not always made clear by candidates.

The colleague's statement has aspects that make sense, but is not broad or specific enough. For example, revenues may continue to oscillate, or oscillate more, for numerous reasons that may or may not affect BJT's inventory levels. This could happen when oil prices fluctuate demand. If oil prices increase, people drive less which, after a delay, decreases the demand for tires and puts downward pressure on tire price and therefore revenue. After a time, oil production increases again and prices decrease. If oil prices decrease, people drive more which, after a delay, increases the demand for tires and allows BJT to increase prices and therefore revenue.

The colleague is correct, that there are cases when having adequate inventory could reduce revenue oscillations. For example, supply side factors like commodity risk and global supply chain issues. With adequate inventory, BJT would be insulated from issues that may cause unexpected production decreases or tire price increases. Instead of increasing prices or another course of action that might oscillate revenue, BJT could temporarily decrease production and release inventories, limiting any impacts on BJT's customers and helping stabilize revenue.

2. Continued

Similarly, BJT would be insulated from demand side changes, releasing inventory if production temporarily failed to keep up.

- (h) Recommend three change management principles BJT management should use to make the cultural change stick.

Commentary on Question:

Candidates performed very well on this part. Half the points were awarded for identifying an appropriate management principle, and half the points were awarded for providing appropriate descriptions. Candidates only received full points if they referenced appropriate details from the case study. Any of the five principles could have been referenced and justified for full marks.

- Match strategy and culture
 - BJT has an ambitious growth strategy but also wants to reduce injuries back to historic levels. BJT should focus their culture shifts on behaviors focused on helping the new plant hit those growth targets while maximizing employee safety during the manufacturing process.
- Focus on a few critical shifts in behavior
 - BJT has an ambitious growth strategy but also deems quality management a core competency. BJT should focus their culture shifts during the integration on two or three small behaviors focused on helping the new plant hit those growth targets while integrating BJT's quality management practices.
- Honor the strengths of your (or in this case the acquisition target's) existing culture
 - BJT management should not try to force the new plant to adopt the BJT culture, but should instead begin by recognizing the strengths of the existing target. BJT may learn nuances that help improve quality, reduce injuries, or improve morale (reduce labor's desire to unionize)
- Integrate formal and informal interventions
 - BJT should introduce their formal quality management processes and existing safety reports. Informal interventions might include a quality control questionnaire or logbook where employees could provide anonymous feedback.
- Measure and monitor cultural evolutions
 - Any changes BJT makes should include some sort of metric. For example, the lost time injury metric (LTIFR) is likely a key metric for the new plant. BJT should note what it's been historically, and track the metric over time to help evaluate whether employee safety changes are sticking.

3. Learning Objectives:

3. The candidate will understand how to apply decision making models to general managerial decisions within specified business constraints.

Learning Outcomes:

- (3a) Apply fundamental techniques and frameworks of management science to make informed business decisions:
 - Apply linear optimization models to managerial decisions.
 - Develop decision trees, scenario tests, and simulation models.
- (3b) Apply statistical and quantification methods to analyze managerial decisions with uncertain conditions:
 - Apply probability distributions to business situations with random variables.
 - Construct optimization models utilizing probability theories.
- (3c) Evaluate business situations and describe how quantitative and statistical methods.

Sources:

Data Models and Decisions - Ch. 5

Commentary on Question:

Candidates generally performed well on this question, in particular the Excel calculations. Although most candidates were able to come up with one or two model limitations and recommendations, few candidates were able to come up with four distinct limitations. Many candidates did not link their recommendations to the case study.

Solution:

- (a) Complete the 100-day simulation model template provided in the exam Excel File to answer the following items.
 - (i) Calculate the expected income for the 100-day simulation of the original route and the new route. Show your work.
 - (ii) Calculate the probability that the new route earns more than the original route on any given day. Show your work.
 - (iii) Calculate the probability that SEA will lose money on the new route on any given day. Show your work.

3. Continued

Commentary on Question:

Most candidates were able to calculate the correct answer in excel and got full marks. Partial marks have been awarded for the remaining candidates.

The response for this part is provided in the Excel spreadsheet.

- (b)
- (i) Identify four limitations of the current model architecture. Justify your answers.
 - (ii) Recommend how to address each limitation identified in part (i).
 - (iii) Describe the expected impacts on the model results if the recommendations in part (ii) are adopted.

Commentary on Question:

Candidates were generally able to come up with two to four limitations of the model. Different variations of the same type of limitation were not awarded points.

- (i) Identify four limitations of the current model architecture. Justify your answers.
 - 1- 100-day time horizon: The model only looks at a simulation for 100 days which may not be large enough to have a credible conclusion.
 - 2- Oversimplification of model factors: The total cost is only a factor of number of flights. Fixed and variable costs can be factored in in a more robust way.
 - 3- Lack of seasonality: The model doesn't take seasonality into consideration. According to the case study, seasonality is an important factor for SEA.
 - 4- Independent variables: In the current model, variables are independent of each other, however, in reality, the cost, number of flights, supply of pilots, and price may all be dependent on each other.
- (ii) Recommend how to address each limitation identified in part (i).
 - 1- 100-day time horizon: Higher number of simulations would add credibility to the results. Either the number of days in one simulation or the number of simulations can be increased.
 - 2- Oversimplification of model factors: Variables can be added to improve the model. From the cost perspective, fixed and variable cost factors can be introduced, or the distribution model can be made more inclusive rather than a limited 4-point model.

3. Continued

- 3- Lack of seasonality: Different sets of model results can be driven depending on the model. Parameters and variables need to be added to allow seasonality.
 - 4- Independent variables: Covariance function can be introduced to have dependence between variables (i.e., price dependent on number flights per day).
- (iii) Describe the expected impacts on the model results if the recommendations in part (ii) are adopted.
- 1- With more simulations, the result is going to be more credible. It might even lead to a different conclusion from the one we draw from the current simulation and model.
 - 2- The cost over 100 days should be relatively close to the 100-day view that we get from the current model as we use a normal distribution. However, we might be able to draw a different conclusion on the profitability of any given day because there is more variability of profitability on any given day after we make cost a variable.
 - 3- We are going to have different sets of model results as we have different sets of parameters for the variables for the routes. And with different sets of model results, we might also draw a different conclusion for busy season vs. non-busy season such as implementing the new route for busy season but not implementing the new route for non-busy season.
 - 4- Covariance will add a more realistic perspective to the model. The results can be significantly different than the current model especially if tail risk is introduced into the model.
- (c) Recommend whether SEA should implement the new route. Justify your answer.

Commentary on Question:

Most candidates concluded that SEA should implement the new route. Reasonable conclusions were awarded points even if the model calculations were incorrect, but the candidates interpreted them appropriately. The recommendation needed to link to the case study for full marks.

I would recommend SEA to implement the new route.

- 1- As shown in model results, the total expected income over 100 days of the new route (25,001) is higher than the original route (20,000) which means the new route is more profitable for SEA over a 100-day period.
- 2- On any given day, it is more likely (53%) that the new route would earn more than the original route.

3. Continued

- 3- There is about 20% probability that SEA will lose money on the new route on any given day, however this may be an acceptable risk to take given the potential cumulative earnings in the long run.
- 4- From a strategy perspective, a new route with multiple number of flights depending on the demand would provide diversification and could better meet the needs of the customers. This aligns with SEA's objectives to prioritize customer needs. They compete against ferries and other alternatives, so flexible fares and schedules align with SEA's competitive strategy.