

# CFE SDM Model Solutions

## Fall 2020

### 1. Learning Objectives:

4. The candidate will be able to analyze and model dynamic systems and evaluate the risks and sustainability of these complex systems.

### Learning Outcomes:

- (4a) Identify and model the dynamic processes within a complex system:
  - Develop and apply causal loop diagrams that model the feedback structure of complex systems
  - Apply stocks and flows to dynamic modeling
  - Apply dynamic modeling to business decisions
- (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

### Sources:

Business Dynamics – Ch. 5 & 15

SDM-187-19: 20 Cognitive Biases that Screw Up Your Decisions  
Organizational Behavior - Ch. 10

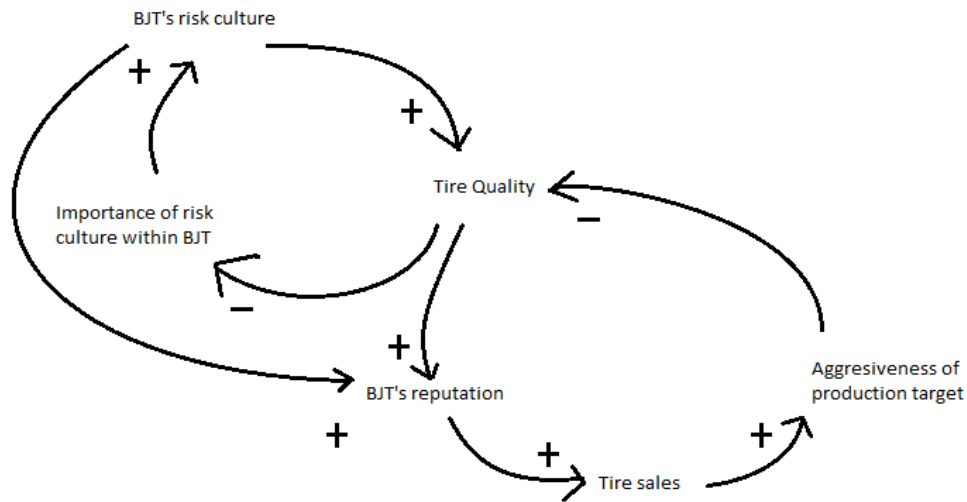
### Solution:

- (a) Sketch a causal loop diagram to model the quality of BJT's tires. Your diagram must include, but not be limited to, the following nodes:
  - Tire sale volume
  - BJT's risk culture

### Commentary on Question:

*Candidates were very creative in their answers, but this part was not done very well. To receive full credit, candidates need to illustrate that risk culture improves tire quality, but tire quality may not reinforce risk culture; subsequently, tire quality leads to more sales, but more sales decrease tire quality.*

# 1. Continued



- (b) Due to the recent tire recall issues, BJT is investigating purchasing insurance to cover the risk of product liability and product recall.
- (i) Explain how this strategy might affect BJT's tire quality.
  - (ii) Sketch a causal loop diagram between tire quality and product recall insurance.

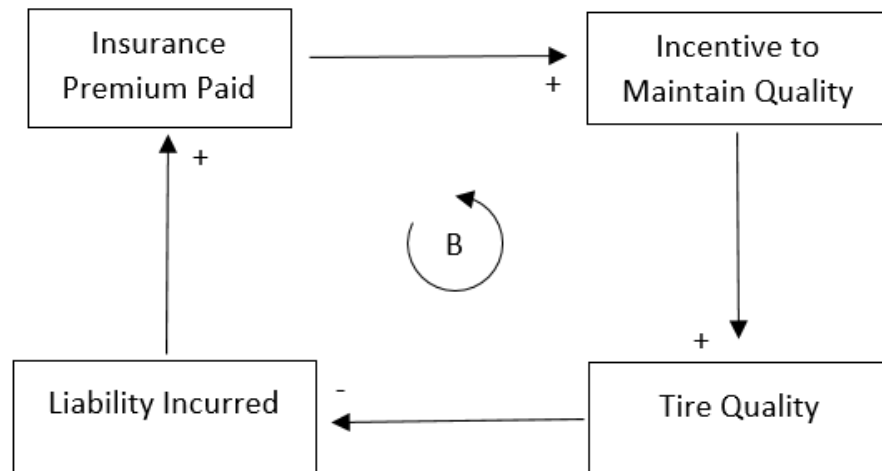
### Commentary on Question:

*For part (i), most candidates received partial credit by correctly indicating that purchasing insurance will decrease tire quality since BJT will no longer need to address product recall issues. However, very few candidates indicated that a decrease in tire quality will increase product liability, forcing BJT to focus more on the quality assurance program, which will increase tire quality again. Candidates need to indicate both sides of the relationship to receive full credit.*

*For part (ii) is a translation of part (i), most candidates received partial credit again by indicating that purchasing insurance will decrease tire quality. However, full credit was only given if candidates indicated both sides of the relationship in their casual loop diagrams.*

# 1. Continued

This proposed strategy would work similar to the current warranty program that BJT offers to its customers. In the beginning, BJT's tire quality may deteriorate, as it no longer has to deal with recall issues directly, which may cause the company to care less about quality assurance and risk culture. However, as liability increases in the form of rising insurance premium, BJT will take the issue more seriously and put more focus on its quality assurance program, which in turn increases its tire quality.



- (c) Explain whether or not Jack's decision is intendedly rational.

**Commentary on Question:**

*Most candidates did very well on this part, stating that Jack's decision is intendedly rational based on the information he was given.*

Yes, Jack's decision is intendedly rational because it is the correct decision if the actual environment were as simple as he presumes it to be. Increased electric car sales and decreased expected tire lifespan will both increase tire sales.

- (d) Critique Jack's decision.

**Commentary on Question:**

*Most candidates did fairly well on this part and offered valid critiques. A sample full-credit answer is provided here.*

Jack's decision might be effective given that the market for EV tires is increasing but isn't necessarily the optimal approach for BJT. He needs to do more to reach an optimal decision, which can only be made when all alternatives are considered. Jack made his decision on 2 endogenous factors, but he failed to consider many more factors that can affect electric car tire sales.

## 1. Continued

Jack reached a decision by scanning the market. This is a preliminary step in decision making but he needs to do more before he can reach a conclusion. He didn't seek feedback from his team, which is necessary for a big decision like this, so everyone accepts it.

He could:

- Conduct competitive analysis of the market
- Consider alternatives like industrial tires
- Look at whether BJT has the right resources to produce electric vehicle tires
- Determine whether BJT will be a cost leader or differentiator
- Examine whether the industry is profitable using tools like SWOT Porter's 5 Forces
- Determine if they can meet profit targets

- (e) Identify the bias exhibited by the committee. Justify your answer.

**Commentary on Question:**

*Many candidates identified groupthink or pro-innovation as the bias and only received partial credit. Identifying the correct bias, and justifying the answer was needed to receive full credit.*

Champion and sunflower bias.

The committee respects Jack Tavares and allows him to dominate the meetings. When Jack has an idea, the other team members showed no resistance due to their respect to him and his seniority. When the boss speaks up first, the likelihood that anybody who's not the boss will speak up with a dissenting opinion is much lower. This is an example of champion bias.

- (f) Recommend two techniques to combat the bias identified in part (e).

**Commentary on Question:**

*Most candidates were able to identify devil's advocate as a technique to combat the bias. A variety of techniques were viable options to receive full credit if the candidate provided justification for it. Candidate must tie their answer back to the case study to receive full credit.*

Technique 1 – Devil's advocate

The team can assign someone to be a devil's advocate where he must list as many things that can go wrong with Jack's plan as he can. This person's performance can then be measured by how many things can he point out.

## **1. Continued**

Technique 2 – Taking an outside view

The team can ask for outside company for advice and analysis on the plan. By hiring outside consultant with independent view, the team will be forced to objectively value this electric car tire plan.

## 2. Learning Objectives:

1. The candidate will understand and apply strategic management concepts and frameworks to corporate financial and ERM business problems.
2. The candidate will understand measures of corporate value and their uses in corporate decision making.
5. The candidate will understand the role that organizational behavior and communication play in organizational decision making and efficacy, as well as learn how ineffective communication is a risk to organizations.

### 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 models such as Porter's five forces.
  - Define types of business-level strategies and recommend an appropriate business-level strategy for a given situation.
  - Explain the impact of competitive dynamics on strategic management.
- (2b) Assess how performance metrics and incentives could impact key business decisions and create value for shareholders:
- Explain how managerial accounting can impact strategic decisions.
  - Explain and recommend methods a firm may use to allocate its costs and how these methods impact the perceived performance of a firm or its component lines of business.

### Sources:

Accounting for Decision Making and Control - Ch. 4 and 5

### Solution:

- (a) Describe the agency problem with Chris Carpenter that occurred leading up to the tire recall crisis. Justify your answer.

### Commentary on Question:

*Candidates did well on this question. Most candidates obtained a majority of points.*

Due to the timing of the incident, it appears that Chris's incentives were not aligned with BJT's, the principal. More specifically, he did the bare minimum to correct the issues identified in production with a sticky valve and the rubber density. If he knew he were going to remain with the company, he likely would have gone even further to ensure the issues identified were not a symptom of a larger underlying problem.

## 2. Continued

- (b) Critique this basis for determining BJT's executive incentive compensation.

**Commentary on Question:**

*Most candidates obtained some points on this question. Points were lost if only negatives were provided with no positives. Weaker responses did not address the time horizon differences between the compensation structure and BJT's long-term goals.*

Pros:

- Creates the incentive for executives to increase revenue and decrease expenses

Cons:

- The investment for a project in the current year will be considered as an expense to offset the net income for the current year. It will hurt the senior management's compensation.
- It ignores the increase of future cash flow and asset value of each business unit.

- (c) Explain how BJT's ownership structure restricts its choices for executive incentive compensation.

**Commentary on Question:**

*Candidates performed poorly on this question. Most failed to make the connection that BJT could not offer company stock or options. Many tried to link executive decisions of BJA, which may lead to different decisions, but does not limit the alternative choices themselves.*

BJT is a wholly-owned subsidiary of BJA. Stocks and options on BJT cannot be offered to senior management, which limits the ability to incentive decisions that are in the long-term best interest of BJT.

- (d) Recommend a change to the proposed incentive compensation basis. Justify your answer.

**Commentary on Question:**

*Candidates performed poorly on this question. Most failed to acknowledge that the performance of the warranty program could not be measured over a single year. Points were also lost from not tying compensation to the warranty program or generally impractical recommendations.*

Structure compensation so that it gets paid out over the life of the warranty based on warranty performance. Decisions on the warranty program should effect compensation over seven years.

## 2. Continued

- (e)
- (i) Explain how the Industrial Organization Model (I/O Model) of Above-Average Returns applies to BJT. Justify your answer.
  - (ii) Explain how an agency problem may impact BJT's ability to earn Above-Average Returns under the I/O Model. Justify your answer.
  - (iii) Recommend a measurement for executive incentive compensation based on the I/O Model of Above-Average Returns without entering a new industry. Justify your answer.

### **Commentary on Question:**

*Candidates performed very poorly on this question. Most could not apply the concepts of the I/O model to an existing firm that has already selected an industry, which is necessary to respond to the question.*

(i)  
The external environment provides constraints for the industry (decreasing oil prices increase tire sales across the board, US right-to-work laws affect the entire industry, natural rubber supply fluctuations have large impacts in all industry players representing 52% of the manufacturing purchases)

BJT uses diversification to expand into subsegments of the market (more recently expanding to reach commercial vehicles)

(ii)  
One of four underlying assumptions of the I/O model is that "decision makers are assumed to be rational and committed to acting in the firm's best interest".

The agency problem fails this assumption and implies that it is not well-positioned to realize above-average returns under the I/O model. By failing this underlying assumption, BJT is not able to ensure management decisions focus on returns.

(iii)  
Research on the I/O model demonstrates that 20% of a firm's profitability is determined based on the industry in which they compete. Incentive compensation should first be tied to BJT's performance and/or Key Risk Indicators relative to the industry.  
Strategies for executive compensation should take into account long-term impacts. Because BJT is a wholly-owned subsidiary of BJA, stocks and options on BJT cannot be offered. Therefore, change in firm value should be incorporated into the compensation structure.



## 2. Continued

Maintaining high quality standards may be used to execute a differentiation strategy. Linking incentive compensation to the performance of the tire warranty program over the lifetime of the warranty, and not a year-to-year measurement, can help achieve this.

- (f) Explain how this action will influence future negotiation tactics used when management is dealing with staff.

**Commentary on Question:**

*Roughly half the candidates performed well on this question. Those who performed poorly did not have a good understanding of negotiation tactics.*

Senior management can no longer use distributive negotiation tactics. By aligning incentives management must switch to integrative negotiation tactics, which will be much more collaborative nature. Management cannot create win-lose scenarios, and must show a win-win outcome is possible.

### **3. Learning Objectives:**

1. The candidate will understand and apply strategic management concepts and frameworks to corporate financial and ERM business problems.
3. The candidate will understand how to apply decision making models to general managerial decisions within specified business constraints.
5. The candidate will understand the role that organizational behavior and communication play in organizational decision making and efficacy, as well as learn how ineffective communication is a risk to organizations.

### **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 models such as Porter's five forces.
  - Define types of business-level strategies and recommend an appropriate business-level strategy for a given situation.
  - Explain the impact of competitive dynamics on strategic management.
- (1b) Evaluate commonly used business growth strategies and their application under different economic risk and business environments:
  - Critique and evaluate internal/organic and external/inorganic growth strategies.
  - Assess and recommend growth strategies under different business situations and market opportunities including innovation and market disruption.
- (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 can improved decision making.

### 3. Continued

- (5a) Apply best practice techniques to structure and communicate ideas logically and persuasively:
- Explain differences between good and poor communication techniques and their implications
  - Apply techniques to structure ideas logically
  - Develop clear fact-based messages that can be communicated persuasively
- (5c) Evaluate the importance of communication to the decision-making processes:
- Explain why communication is strategically important to organizations
  - Describe how information is communicated within organizations
  - Describe organizational and individual barriers to effective communication
  - Identify the risks of ineffective communication
  - Explain how to overcome communication barriers and minimize risks of ineffective communication

**Sources:**

Case Study 2020 section 7 Darwin Life Insurance Company and 8 Snappy Life Insurance Company, 89-127

Data, Models, and Decisions: The fundamental of Management Science Ch 1, Decision Analysis 1-34, 54-65

Organizational Behavior - Ch. 9, 294-5

**Solution:**

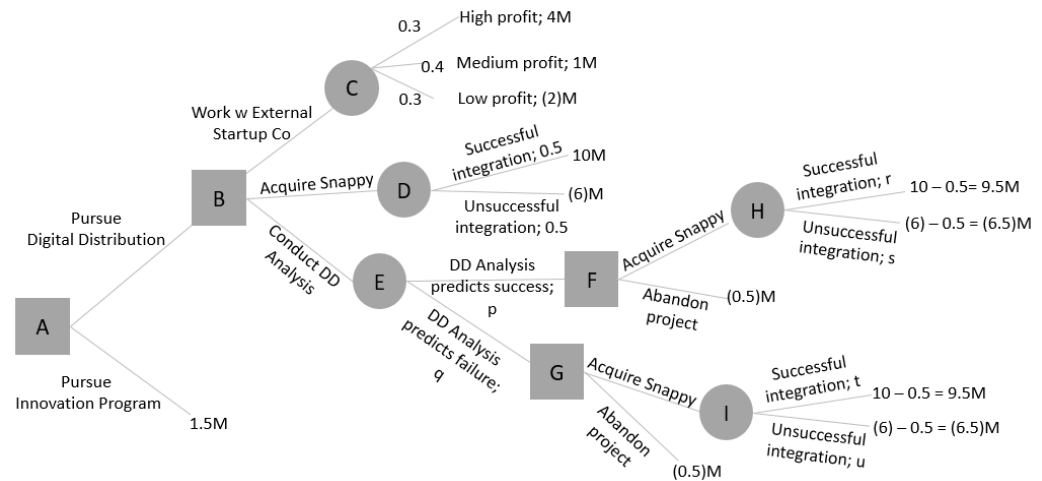
- (a)
- (i) Construct a decision tree for Darwin.
  - (ii) Calculate the Expected Monetary Value (EMV) of the optimal decision. Show your work.

**Commentary on Question:**

*Some of the key elements of the decision tree that were required are:*

- Shape/structure of tree
- Monetary value at the end of each branch
- Digital distribution vs innovation program as the first node
- Start-up vs Snappy vs due-diligence branching
- Due-diligence outcome and acting on the due-diligence (acquire vs abandon)
- Listing all three outcomes of working with startup
- Branches for successful vs unsuccessful integration with Skippy

### 3. Continued



- (ii) Some students didn't calculate the conditional probabilities correctly. Expected values of other nodes were mostly calculated well, unless the decision tree was not constructed correctly to begin with. Some partial marks were given for a different interpretation of the statement "A CRS prediction of success is accurate 95% of the time", where instead of interpreting it as  $P(\text{DD indicates success} \mid \text{integration success}) = 0.95$  it was interpreted as  $P(\text{integration success} \mid \text{DD indicates success}) = 0.95$ .

Answer:

$$\text{EMV (C)} = 0.3 \cdot 4 + 0.4 \cdot 1 + 0.3 \cdot (-2) = 1\text{M}$$

$$\text{EMV (D)} = 0.5 \cdot 10 + 0.5 \cdot (-6) = 2\text{M}$$

$$P(\text{integration success}) = P(\text{integration failure}) = 0.5$$

$$P(\text{DD indicates success} \mid \text{integration success}) = 0.95$$

$$P(\text{DD indicates failure} \mid \text{integration success}) = 1 - 0.95 = 0.05$$

$$P(\text{DD indicates failure} \mid \text{integration failure}) = 0.8$$

$$P(\text{DD indicates success} \mid \text{integration failure}) = 1 - 0.8 = 0.2$$

$$P(\text{DD indicates success and integration success})$$

$$= P(\text{DD indicates success} \mid \text{integration success}) \times P(\text{integration success})$$

$$= 0.95 \times 0.5 = 0.475$$

$$P(\text{DD indicates failure and integration failure})$$

$$= P(\text{DD indicates failure} \mid \text{integration failure}) \times P(\text{integration failure})$$

$$= 0.8 \times 0.5 = 0.4$$

$$P(\text{DD indicates success and integration failure})$$

$$= P(\text{DD indicates success} \mid \text{integration failure}) \times P(\text{integration failure})$$

$$= 0.2 \times 0.5 = 0.1$$

### 3. Continued

$$\begin{aligned}
 &P(\text{DD indicates failure and integration success}) \\
 &= P(\text{DD indicates failure} \mid \text{integration success}) \times P(\text{integration success}) \\
 &= 0.05 \times 0.5 = 0.025
 \end{aligned}$$

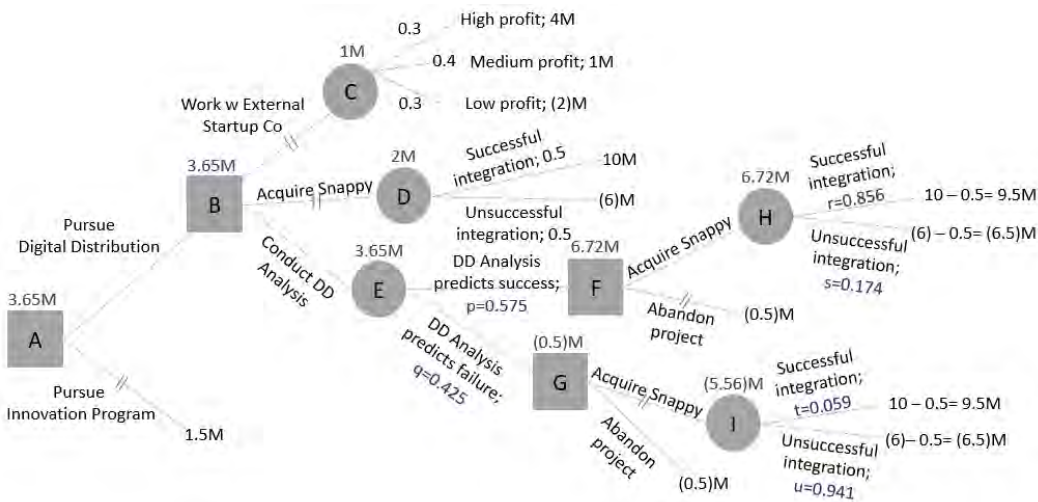
|                     | DD predicts success | DD predicts failure | Total |
|---------------------|---------------------|---------------------|-------|
| Integration success | 0.475               | 0.025               | 0.5   |
| Integration failure | 0.1                 | 0.4                 | 0.5   |
| Total               | 0.575               | 0.425               | 1     |

$$\begin{aligned}
 r &= 0.475/0.575 = 0.826086957 \\
 s &= 0.1/0.575 = 0.173913043 \\
 t &= 0.025/0.425 = 0.058823529 \\
 u &= 0.4/0.425 = 0.941176471
 \end{aligned}$$

$$\begin{aligned}
 \text{EMV (H)} &= (r \cdot 9.5 + s \cdot (6.5)) = 0.826086957 \cdot 9.5 + 0.173913043 \cdot (6.5) = 6.72 \\
 \text{EMV (I)} &= (t \cdot 9.5 + u \cdot (6.5)) = 0.058823529 \cdot 9.5 + 0.941176471 \cdot (6.5) = (5.56)
 \end{aligned}$$

$$\begin{aligned}
 p &= P(\text{DD indicates success}) = 0.575 \\
 q &= P(\text{DD indicates failure}) = 0.425
 \end{aligned}$$

$$\text{EMV(E)} = 6.72 \cdot 0.575 + (0.5) \cdot 0.425 = 3.65$$



EMV of optimal decision is 3.65M, pursue digital distribution, conduct DD and if DD predicts success then acquire Snappy, but if DD predicts failure then abandon project to acquire Snappy.

### 3. Continued

- (b)
- (i) Critique the general use of decision trees in determining which initiative to pursue.
  - (ii) Describe two additional considerations specific to Darwin.
  - (i) Some possible considerations to discuss were:

Negative considerations:

- Does not consider the subjective (non-quantifiable) factors such as not reflecting business strategy, e.g. cultural fit of digital distribution, vs pursuing program innovation.
- It is difficult to assign accurate probabilities
- Averaging out the outcomes in the EMV method masks substantial risk, such as the outcomes where losses are greater than \$5m.
- A decision tree decision and outcome node should have all possibilities identified, such that they are mutually exclusive and collectively exhaustive. E.g in the first decision node, there are most likely more possibilities than the just the digital distribution and innovation program.

Positive considerations:

- Quantifies the challenges of M&A
- Provides clarity of the decision problem. I.e. Demonstrating structure and sequence of decisions and uncertain events and the interplay between them.
- Using the EMV method of evaluation in decision trees is appropriate when the range of outcomes is within the normal considerations of risk.
- Highlights the importance of key data. Identifies critical nodes of either high potential losses or gains, where further analysis should be performed.

- (ii) It is noted from the case study that agents are wary of digital distribution in general so it may create additional cultural repercussions or challenges in integration of Snappy.

Darwin has a risk appetite statement that earnings cannot be negative with probability 5%. This is not considered in the valuation of the node or informing the decision to conduct due diligence (which de-risks the downside scenario of unsuccessful integration). It could be that the risk of unsuccessful integration of Snappy is beyond Darwin's risk tolerance but this is not accounted for in the tree.

### 3. Continued

- (c)
- (i) Describe the steps in a two-way communication model.
  - (ii) Propose a strategy for Brandon to communicate the recommendation to the Board using a two-way communication model. Justify your answer.

**Commentary on Question:**

*The majority of marks were awarded for choosing how to communicate and receive feedback, but references to syllabus material were required too.*

- (i) The steps in a two-way communication model are:
  - Sender encodes a message
  - Sender sends the encoded message through a communication medium
  - Receiver decodes the message and interprets its meaning
  - Feedback: receiver encodes the received message and sends it or a response to it to the original sender
- (ii) Brandon will need to explain the results of the decision tree, including the EMV as a determinant. This will require formal numerical text. Sending it out in a written format ahead of time is a good idea to give the board time to review it. Brandon then needs to explain the process and materials in-person to the board to get both verbal and non-verbal feedback from board to ensure understanding. Effective communication occurs when the received message has the same meaning as the sent message.

#### 4. Learning Objectives:

4. The candidate will be able to analyze and model dynamic systems and evaluate the risks and sustainability of these complex systems.

#### Learning Outcomes:

- (4a) Identify and model the dynamic processes within a complex system:
  - Develop and apply causal loop diagrams that model the feedback structure of complex systems
  - Apply stocks and flows to dynamic modeling
  - Apply dynamic modeling to business decisions
- (4c) Evaluate complex systems and describe how actuarial principles can mitigate risks and improve sustainability.

#### Sources:

Business Dynamics Chapter 4, 107-133

Business Dynamics Chapter 5, 137-190

Business Dynamics Chapter 15

#### Solution:

- (a) Describe the feedback structure associated with each of the three fundamental modes of behavior in dynamic systems.
  1. **Exponential growth** arises from positive(self-reinforcing) feedback. The larger the quantity, the greater its net increase, further augmenting the quantity and leading to ever-faster growth.
  2. **Goal seeking** arises from negative feedback. Negative loops seek balance, equilibrium, and stasis. Negative feedback loops act to bring the state of system in line with a goal or desired state. If there is a discrepancy between the desired and actual state, corrective action is initiated to bring the state of the system back in line with the goal.
  3. **Oscillations** are caused by negative feedback loops. The state of the system is compared to its goal, and corrective actions are taken to eliminate any discrepancies. In an oscillatory system, the state of the system constantly overshoots its goal or equilibrium state, reserves, then undershoots. The overshooting arises from the presence of significant time delays in negative loop. The time delays cause corrective to even after the state of the system reaches its goal, forcing the system to adjust too much, and triggering a new correction in the opposite direction



## 4. Continued

- (b) Predict Frenz-Shanghai's mode of behavior during the following time periods:
- (i) During the first five years following the opening of the first Frenz-Shanghai. Justify your answer.
  - (ii) After the first five years. Justify your answer.

### Commentary on Question:

*The intent of this question was for candidates to apply business dynamics concept in an underdeveloped market, specifically where there are other fast-growing competitors. Candidates who modelled the correct mode of behaviour, but with different timelines were awarded full marks.*

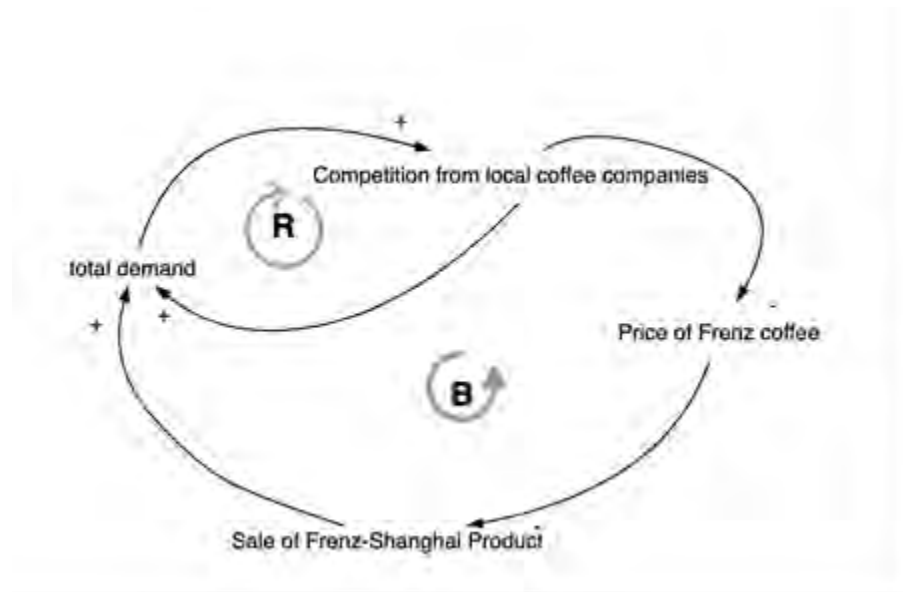
- (i) **Exponential growth.** At first, growth will be slower due to the low popularity of coffee drinks. The rate of growth will increase once more people switch to coffee due to the low market saturation. As more people switch to coffee, it will further increased popularity of coffee, leading to even faster growth for Frenz.
  - (ii) **Oscillation.** After surviving the first five years in an expanding Chinese coffee market, Frenz will face more challenges. The coffee market has a higher market saturation as more drink shops offer coffee-related drinks. Competitors will halt the growth for long run. Customer loyalty will decrease as more competitors enter the market. However, Frenz successful market promotions may cause short term increase in growth. The growth will be halted once the other competitors respond with a delay impact.
- (c) Sketch a causal loop diagram by including at least the following nodes:
- Competition from local coffee companies
  - Frenz-Shanghai coffee sales
  - Total coffee demand in Shanghai
  - Price of Frenz-Shanghai coffee

### Commentary on Question:

*There were many recurring errors with modelling.*

- *Many candidates either did not identify re-enforcing and balancing loops or applied them incorrectly (e.g., identified a balancing loop as a re-enforcing loop).*
- *Basic concepts of supply and demand included in the syllabus materials were not followed (e.g., demand and/or competition were independent of the loops).*

## 4. Continued



(d) Explain whether or not each of the below scenarios create a negative feedback loop for Frenz-Shanghai's growth. Justify your answer.

- (i) Financial crisis
- (ii) New competitors

**Commentary on Question:**

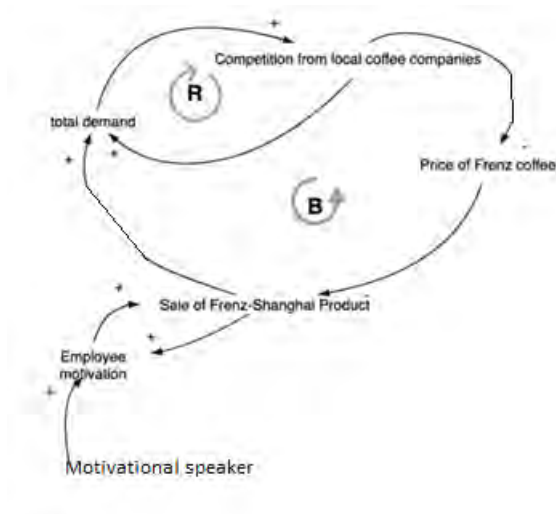
*This question in particular was poorly done. The key element to remember is that negative feedback loops can only be created by Frenz' actions.*

- (i) A financial crisis is an external factor for the model. It does not depend on Frenz' success, so it cannot create a negative feedback loop.
  - (ii) New competitors is not an external variable. It does depend on Frenz success: the more successful Frenz, the more competitors that enter the market. It will create a negative feedback loop to the model.
- (e) Describe the impact of the motivational speaker on the model from (c) based on the market growth model. Justify your answer.

**Commentary on Question:**

*The intended application was for the motivational speaker to give a short-term boost to Frenz' staff to sell more coffee. Many candidates answered this question with the assumption that the motivational speaker would encourage consumers to purchase coffee; that is advertising. Marks were awarded for this and other answers as long as they addressed the impact of the action and how long the impact would last.*

## 4. Continued



## 5. Learning Objectives:

2. The candidate will understand measures of corporate value and their uses in corporate decision making.
5. The candidate will understand the role that organizational behavior and communication play in organizational decision making and efficacy, as well as learn how ineffective communication is a risk to organizations.

### Learning Outcomes:

- (2a) Assess various measures that firm can use to assess value and recommend appropriate measures to evaluate corporate value.
- (5b) Evaluate the impact of human behavior factors on the effectiveness of decision making processes within organizations:
  - Explain the role of cognitive biases on making suboptimal individual decisions
  - Evaluate the role of organizational behavior on organizational decision-making processes and efficacy

### Sources:

Damordaran on Valuation: Chapter 7 Relative Valuation

Damordaran on Valuation: Chapter 9 Value Multiples

Damordaran on Valuation: Chapter 13 Value of Control

Cognitive bias

Organizational Behavior: Chapter 12 Conflict, Negotiation, Power, and Politics

### Solution:

- (a) Determine which of the five business-level strategies is used by BJA. Justify your answer.

### Commentary on Question:

*Candidates generally performed well answering this question. Candidates who did not provide case-study examples to support the listed business-level strategy lost a significant number of points.*

Comfort, punctuality and safety are the three important virtues that the company has adopted. In an industry struggling with these virtues, BJA is looking to focus more on creating additional value. Loyalty program and Travel insurance further differentiate BJA from competitors.

Premium business class customers who are not sensitive to price represents the majority of the client base. This implies that service differentiation creates more value for these clients compared to low-cost.

## 5. Continued

- (b) Describe two reasons why BJA would vertically integrate with an aircraft manufacturer based on BJA's business-level strategy. Justify your answer.

**Commentary on Question:**

*Most candidates were able to receive some points. Candidates missed points by not answering the question in relation to BJA's business-level strategy.*

Manufacturing of Airplanes is an adjacent strategy to the current one.

BJA seeks to be different from competitors on as many levels as possible. Upgrading their fleet, controlling both the quality and the differentiating features will help achieve this.

Combined with BJA's strong reputation, the strong safety record of the manufacturers can both boost public confidence and create value for customers who care about safety.

Given the 10-year-old inventory of BJA's planes, the company will need to revitalize their fleet in the near future, increase the attractiveness of vertically integrating at this time.

- (c) Your coworker notes that the price-to-book value ratio is low for Skylite, and concludes that Skylite must be a better price than Xolar.
- (i) List the four fundamental determinants of price-to-book value ratio.
- (ii) Explain two potential reasons why Skylite may not be cheaper than Xolar even though Skylite has a lower price-to-book value ratio.
- (i)
1. Expected Growth Rate
  2. Payout
  3. Cost of Equity (risk)
  4. ROE
- (ii) It is possible that Skylite's price-to-book ratio is low due to their relatively low ROE compared to Xolar, Xolar's higher expected growth than Skylite, or Skylite's risk being significantly higher than the risk for Xolar.

## 5. Continued

- (d) Jim Peters, head of the risk management committee at BJA, sees the table above. You are copied on the following email he sends in reply:

“Here’s some advice from someone that has done a lot of valuation work. This isn’t middle school—no one at my level cares about medians. All you need for this analysis is the average for the industry.”

- (i) Identify the cognitive bias that Jim is exhibiting in this email. Justify your response.
- (ii) Propose a strategy to overcome the bias identified in part (i). Justify your answer.
- (iii) Identify the base of individual power to which Jim is appealing in his email. Justify your response.
- (iv) Critique Jim’s recommendation.

### **Commentary on Question:**

*Candidates scored very well on this question.*

- (i) The cognitive bias that Jim is exhibiting is overconfidence  
He is using his “expertise” from his background as a bank and as a hedge fund manager (as mentioned in the case study) and convinced that he is right.
- (ii) Take an Outside view  
This strategy considers what has happened with similar ventures and what advice you would give someone else if you were not involved in the endeavor.
- (iii) Jim is using a legitimizing tactic or expert.  
He is making his request seem official as he is leveraging his seniority to convince the coworker about how things are typically done.
- (iv) Jim is incorrect in wanting to disregard medians for relative valuation.  
The industry median should thus be more representative of the typical sample firm in the industry  
For price-to-book, the book value of equity may be negative. Because the lowest value that any company can register for price-to-book is floored at zero, the average of the multiples will have a positively skewed distribution.

## 5. Continued

- (e)
  - (i) Explain whether firm value or equity value should be used to compare Xolar and Skylite.
  - (ii) Determine if Skylite is undervalued relative to the comparable firms in the aircraft industry.
  - (iii) Determine if Xolar is undervalued relative to the comparable firms in the aircraft industry.

### **Commentary on Question:**

*Most candidates were able to determine that firm value should be used when comparing companies. Candidates were mostly unable, however, to describe why the companies were or were not considered undervalued.*

- (i) It is better to use the metrics related to firm value instead of equity value. There are reasons that price-to-book may be higher or lower, and there is not enough information to conclude why. Based on these firm value measures, an undervalued firm should have a low enterprise value-to-capital ratio while maintaining a high return on capital.
  - (ii) Skylite has a high Enterprise Value/Invested Capital relative to the industry but is not considered undervalued given its relatively low ROC. Skylite is not considered undervalued.
  - (iii) Xolar also has a high Enterprise Value/Invested Capital but still maintains an ROC above industry average. These two factors in combination implies that Xolar is undervalued.
- (f) Determine whether BJA should downsize each of the manufacturer's capabilities (A to F) following acquisition. Justify your answer.

The rationale for downsizing is finding synergies that create excess capacity and improve performance.

A: Do not downsize: this is the reason BJA is purchasing a manufacturer.

B: Downsize: reducing expenses, the acquired company can use existing frameworks for BJA.

C: Do not downsize: safety and business class are key drivers for BJA.

D: Do not downsize: maintaining aircrafts is not done by BJA.

E: Do not downsize: customization and differentiation are key drivers for BJA.

F: Downsize: BJA already has HR functions.

## 5. Continued

- (g) Recommend which company BJA should acquire. Justify your answer.

**Commentary on Question:**

*To receive full marks, candidates needed to acknowledge that acquiring Skylite aligns with BJA's business-level strategy. Candidates were able to receive some points for justifying the acquisition of Xolar.*

BJA should acquire Skylite since it is more aligned to BJA's strategic goals. Safety is one of BJA's higher priorities, lining up well with Skylite's better safety record.

- (h) Describe the effects of BJA's acquisition on the following two Forces of Competition, from the perspective of the aircraft manufacturer.
- (i) Rivalry of existing competitors
  - (ii) Bargaining power of customers

**Commentary on Question:**

*Most candidates answered this question well. Candidates who performed poorly mostly lost marks by answering the question from the perspective of the airline rather than the manufacturer.*

- (i) The acquired manufacturer will no longer be competing with the other manufacturer since they will have mutually exclusive customer bases – the acquired manufacturer will only produce aircraft for BJA while other manufacturer will only produce for non-BJA airlines.
- (ii) The acquired manufacturer's only customer will be its owner resulting in a large increase in the customer's bargaining power. The other manufacturer will be the only provider for its numerous customers, greatly lowering the bargaining power of its customers.



## 6. Learning Objectives:

1. The candidate will understand and apply strategic management concepts and frameworks to corporate financial and ERM business problems.
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 models such as Porter's five forces.
  - Define types of business-level strategies and recommend an appropriate business-level strategy for a given situation.
  - Explain the impact of competitive dynamics on strategic management.
- (4a) Identify and model the dynamic processes within a complex system:
- Develop and apply causal loop diagrams that model the feedback structure of complex systems
  - Apply stocks and flows to dynamic modeling
  - Apply dynamic modeling to business decisions
- (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

### Sources:

Data, Models, and Decisions: The fundamentals of Management Science (7 and 9) 323-410, 451-484

### Commentary on Question:

*Candidates were intended to demonstrate knowledge of linear and discrete optimization via the set-up of a relatively straight-forward discrete optimization. Candidates that interpreted the ask to maximize revenue generally received full or nearly-full credit throughout the question. Partial credit was given to those that attempted to maximize profit or set up their original constraints incorrectly, as long as future optimization was correct for their given set-up. However, many candidates that attempted to maximize profit rather than revenue struggled to adequately describe how they accounted for the cost of a voucher opposed to the cash refund and construct appropriate constraints for each scenario.*

## 6. Continued

### Solution:

(a)

- (i) Define discrete optimization.
- (ii) Explain how linear optimization can be used to approximate solutions to discrete optimization problems.

### Commentary on Question:

*Part (a) was generally well answered with those receiving full credit adequately describing discrete optimization as requiring a whole number solution.*

- (i) An optimization model is said to be a discrete optimization model if all of the constraints and the objective function are linear functions, and all of the decision variables are required to be whole numbers.
- (ii) The usual linear optimization method can be used to find an ‘approximate’ solution without consideration for the discrete requirement that the solution be a whole number. This solution is certain to be close to the discrete solution. The solution can then be rounded and the nearest possible discrete solutions tested to determine the optimal solution with this additional constraint.

(b)

- (i) State the objective function.
- (ii) State the constraint functions.

### Commentary on Question:

*Candidates that did well on Part (b) recognized the question requested revenue to be optimized and recognized that vouchers do not impact revenue. Partial credit was given to those that attempted to optimize profit with adequate explanation of how they handled the cost of the voucher. Candidates that approached this route should have recognized the cost of the voucher is less than the face amount.*

Objective – maximize revenue from ticket sales

Let  $x$  be the number of tickets sold

Let  $y$  be the number of “overbooked” passengers who arrive, but are not given a seat on a flight

- (i) The objective function is:  $\text{Max } 900 * x$

## 6. Continued

- (ii) The constraint functions are:  
 $0.02 * 900 * x - 1200 * y \geq 0$  ; vouchers issued are no more than 2% of final ticket sale revenue  
 $0.01 * x - y \geq 0$  ; no more than 1% of customers issued vouchers for overbooking  
 $x$  has a positive integer value
- (c) For the optimization problem defined in part (b):
- (i) Calculate the optimal solution. Show your work.
- (ii) Critique the inclusion of both constraint functions in the model.

### Commentary on Question:

*Candidates who correctly identified the objective function and constraint functions in part (b) performed well on part (c) as well. Full credit was given for correct optimization of alternate answers to part (b); however, many candidates constructed answers to part (b) that were more difficult to optimize and achieve credit on part (c)*

- (i) the expectation of  $y$  can be expressed as a function of  $x$ , namely:

$$y = \max(0.95x - 300, 0)$$

$$\text{if } x \leq 315 \text{ then } y = 0$$

$$\text{if } x > 315 \text{ then } y > 0$$

when  $x > 315$ ,

$$0.02 * 900 * x - 1,200 * (0.95 * x - 300) \geq 0$$

$$= 18 * x \geq 1,140 * x - 360,000$$

$$= x \leq 360,000 / 1,122 = 320.86$$

since  $x$  must be discrete,  $x \leq 320$

$$0.01 * x - (0.95 * x - 300) \geq 0$$

$$= -0.94 * x \geq -300$$

$$= x \leq 300 / 0.94 = 319.15$$

since  $x$  must be discrete,  $x \leq 319$

Therefore, the optimal solution subject to all the constraints occurs when  $x = 319$ . The optimal solution is  $900 * 319 = 287,100$ .

## 6. Continued

- (ii) Since the expectation of  $y$  can be expressed as a function of  $x$  (as they are defined in part b)), this problem can be simplified into a one-dimensional linear optimization problem. As such, one constraint will always dominate the other. In this case, the requirement to have issued voucher value be no greater than 2% of total revenue is dominated by the requirement to have no more than 1% of customers subject to overbooking.
- (d) Recent legislation was passed that requires airlines to offer overbooked customers a voucher valued at a minimum of \$600 plus twice the value of the original ticket price.

State the new constraint functions.

### Commentary on Question:

*To obtain full credit, candidates only needed to restate the value of the voucher in the constraint function. Those candidates that attempted to optimize revenue or include the cost of vouchers as a revenue item struggled with part (f) as their set up complicated this constraint.*

Due to the recent legislation, the refund voucher must be at least a value of:

$$\mathbf{\$600 + \$900*2 = \$2,400}$$

Therefore, the objective function remains unchanged as follows:

$$\mathbf{\max 900*x}$$

The new constraint functions are as follows:

$0.02 * 900 * x - 2400 * y \geq 0$  ; vouchers issued are no more than 2% of final ticket sale revenue

$0.01 * x - y \geq 0$  ; no more than 1% of customers issued vouchers for overbooking

$x$  has a positive integer value

- (e)
- (i) Calculate the optimal solution for the optimization model defined in part (d). Show your work.
- (ii) Explain how the relationship between the constraint functions has changed compared to how they were defined in part (b).

### Commentary on Question:

*Candidates that correctly solved their stated optimization and constraint functions received full credit for part (i). Partial credit was given for correct optimization of constraints that set up incorrectly.*

## 6. Continued

- (i) when  $x > 315$ ,

$$\begin{aligned}0.02*900*x - 2,400*(0.95*x - 300) &\geq 0 \\= 18*x &\geq 2,280*x - 720,000 \\= x &\leq 720,000/2,262 = 318.30 \\ \text{since } x &\text{ must be discrete, } x \leq 318\end{aligned}$$

Therefore, the new optimal solution subject to all the constraints occurs when  $x = 318$ . The optimal solution is  $900*318 = 286,200$ .

(ii) Due to the more severe penalty imposed on BJA when overbooking, the requirement to have issued voucher value be no greater than 2% of total revenue becomes more stringent than the requirement to have no more than 1% of customers subject to overbooking (which as a result is no longer the dominant constraint).

- (f) Assuming all overbooked customers elect to take the cash refund option:
- (i) Explain how this new legislation changes the model.
- (ii) Calculate the new optimal solution. Show your work.

### Commentary on Question:

*Candidates that recognized the original vouchers did not cost BJA the full cash amount did well on part (f). No credit was given for answers that assumed cash and vouchers were of equivalent value.*

- (i) This latest legislation will impact BJA's revenue, as BJA can no longer rely on providing reimbursements in the form of vouchers to overbooked customers. BJA must now provide cash refunds to customers who are overbooked, which will directly impact revenue and consequently the objective function.

Therefore, the objective function must be redefined as follows:

$$\max 900*x - 2,400*y$$

(ii) The consequence of this change is that  $y$  must now be minimized in order to maximize the objective function, while keeping  $x$  as large as possible.

## 6. Continued

$$y = 0.95 * x - 300$$

set  $y = 0$  and solve for  $x$ ,

$$0 = 0.95 * x - 300$$

$$300/0.95 = x = 315.79$$

since  $x$  must be discrete, either  $x = 315$  or  $x = 316$

$$\text{when } x = 315, y = \max(0.95 * 315 - 300, 0) = 0$$

$$\text{objective function: } 900 * 315 - 2,400 * 0 = 283,500$$

$$\text{when } x = 316, y = \max(0.95 * 316 - 300, 0) = 0.2$$

$$\text{objective function: } 900 * 316 - 2,400 * 0.2 = 283,920$$

Therefore, the new optimal solution is **283,920** and occurs when  $x = 316$

(g) Critique the optimization model's representation of:

- (i) The overbooking strategy. Justify your answer.
- (ii) BJA's business strategy. Justify your answer.

### **Commentary on Question:**

*Candidates generally provided adequate answers critiquing the model in light of BJA's corporate strategy. Full credit answers should recognize the model for overbooking was too simplistic and didn't account for a number of variables that would impact the number of overbooked passengers nor longer term revenue impacts of overbooking. A full credit answer would also recognize BJA's strategy of emphasizing safety and/or their target business travel customer.*

- (i) The model is too simple. The current version of the model is deterministic and does not consider that there is variability in the number of people who do/do not show up for a flight (i.e., will be higher or lower than 5%, even 0%, for each flight).
  - (ii) The strategy of optimizing revenue via allowing for overbooking does not consider BJA's overall business strategy. It may be inconsistent with a strategy and marketing an emphasis on safety and commitment to quality. The potential of overbooking may be unacceptable to business travelers and could cause BJA to ultimately lose revenue from that segment.
- (h) Design a solution to incentivize overbooked customers to choose the voucher over the full cash refund equivalent to the voucher value. Justify using choice architecture.

## 6. Continued

**Commentary on Question:**

*Candidates were intended to answer part (h) within the context of system 1 and 2 thinking about how each could be used or bypassed to incentivize passengers to choose a travel voucher. Partial credit was given for sound strategies to influence a passenger's decision without reference to rational based on choice architecture.*

BJA may incentivize customers to choose a voucher by instantly issuing digital vouchers and attaching pictures of locations that could be reached with a voucher of their amount. This leverage system 1 thinking by both simplifying the process for obtaining a voucher vs. requesting cash and arousing a passenger's emotion by illustrating the locations they could visit.