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AND ASSOCIATES

We make winning decisions.

DAYLIGHT ALCHEMY CORPORATION

THE CYCLONE ENZYME

STRATEGIC DECISION ASSESSMENT

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Contents

1 Overview

PURPOSE

The following report is intended to advise Daylight Alchemy Corporation (DA Corp.) in their production and marketing strategy for their newest enzyme, Cyclone. A complete deterministic and probabilistic assessment of the decision alternatives provided by Daylight Alchemy Corporation will be performed. Framing and scope of the decision has been established with DA Corp. Per our assessment, we will recommend a strategic course of action.

1.1 BACKGROUND INFORMATION

Daylight Alchemy Corporation specializes in the development and production of synthetic enzymes. They have recently developed a new enzyme, termed Cyclone, that has been assessed to be of value for winemakers. While the wine-making industry has been established as a viable market, DA Corp. has little experience in marketing and limited production capabilities in their current state. DA Corp. management team is seeking decision analysis expertise to inform the appropriate course of action for taking Cyclone to market.

1.2 FRAMING AND SCOPE

A variety of decisions must be assessed to take the enzyme to market. These decisions include locations to market, production process, "stacking" of Cyclone with other enzymes in their portfolio, and how to handle production and marketing under demand uncertainty. Per discussion with DA Corp., this analysis assumes that Cyclone will only be produced in the United States (due to regulatory concerns), production will be done with the new NX-10 process, and that Cyclone will not be "stacked" with other enzymes in the development portfolio. Under these framing constraints, decision alternatives relating to production and marketing will be analyzed.

1.3 DECISION ALTERNATIVES

Daylight Alchemy has limited production capabilities (2.5 million units of enzymes per year) and very little experience in marketing. DA Corp. can choose to operate with their current infrastructure or invest in the expansion of their production capabilities by 6 million units of enzymes per year by the time they would start production. The necessity for this expansion depends on the demand for the enzyme. In addition to these fully in-house approaches (production and marketing done on their own), DA Corp. has also identified two alternative courses of action that involve a strategic partnership with EnzyTech, a larger chemical engineering firm. One alternative is to have a joint venture while the other is to establish a royalty partnership. Below we present the detailed breakdown of the four alternatives. These will be the only alternatives assessed in the deterministic and probabilistic analysis.

No Partnership / No Expansion

Under the ***No Expansion / No Partnership*** alternative, DA Corp. will do production and marketing with its current infrastructure. Under this alternative, maximum production capacity is 2.5 million units per year.

No Partnership / Expansion

In the ***No Partnership / Expansion*** alternative, DA Corp. will invest in an expansion in its plant infrastructure to increase its production capacity. Marketing and production will be done in-house by DA Corp. Under this alternative, maximum production capacity is 8.5 million units per year.

Joint Venture

The ***Joint Venture*** alternative entails working with EnzyTech to cover costs for the expansion and assists in marketing. In this agreement, EnzyTech will pay for DA Corp. to produce the infrastructure expansion in exchange for a 60% share of the net profits (before tax). DA Corp. would then be responsible for all production while EnzyTech would perform all marketing. Maximum production capacity would be 8.5 million units per year.

Royalty

With the ***Royalty Partnership*** alternative, DA Corp. does not do any production or marketing. Instead, DA Corp. licenses the enzyme to EnzyTech. EnzyTech will do all production and marketing, but DA Corp. will receive a royalty payment of 2% of all sales revenue. There is no production capacity constraint in this scenario.

1.4 ASSUMPTIONS

A variety of assumptions relating to production capabilities, time horizon, risk profile, revenue, and uncertainties. We outline related assumptions below.

Production Capabilities

- Baseline capacity is 2.5 million units in all cases
- Expansion capacity is an additional 6 million units in the expansion and joint venture case
- Expansion will be completed in time for first production year (must be paid at this time)

Time Horizon

- After 10 years of Cyclone sales, a new product will have been developed
- Use of expansion after Cyclone sales have ended should not be considered
- Do not consider salvage value of expansion after sales end

Risk Profile

- Follows delta-property

- Risk tolerance of $30 million

Finances and Cash Flow

- Sales should be considered in terms of potential demand and capacity (the minimum of the two is what is attainable)
- Sales growth rate is constant
- Demand depends on who does marketing, but growth rate does not
- Tax rate of 38%
- Expansion cost creates negative cash flow on initial year (resulting in tax credit)
- Discount rate of 8% (no discount on tax credit)
- All cash flows occur at the start of the year
- All cash is presented in year 2020 dollars

Uncertainties

- Cost of expansion
- Initial demand of Cyclone
- Demand growth rate
- Unit production cost
- Market price of Cyclone (Unit Revenue)

One significant further assumption is made for this analysis, which will impact the results of the simulations that follow. We assume that DA Corp. will choose to sell no units of the enzyme in the case where the unit production cost is greater than the unit revenue.

2 Formulation

This section is intended to help presented the case being assessed. A strategy table is used to compare the decision alternatives to each other and an influence diagram is used to show the relevance between different aspects influencing a decision. A force field diagram is deemed to be unsuitable for this analysis as we are assessing multiple alternatives, not a do or don't do binary decision. Decision hierarchy analysis is also deemed to be inappropriate based on discussions with DA Corp. The agreed upon frame and scope limit the analysis to a single decision as opposed to multiple decisions needing to be made in series. We will use a strategy table and decision diagram.

2.1 Strategy Table

A strategy table is developed to map out all possible decision alternatives. The decision alternatives presented for assessment by DA Corp. are indicated by the color coding in the figure. The features that characterize each decision alternative are outlined in the columns. These features include plant expansion, financier of the expansion, producing company, marketing company, and profit structure (for DA Corp.).

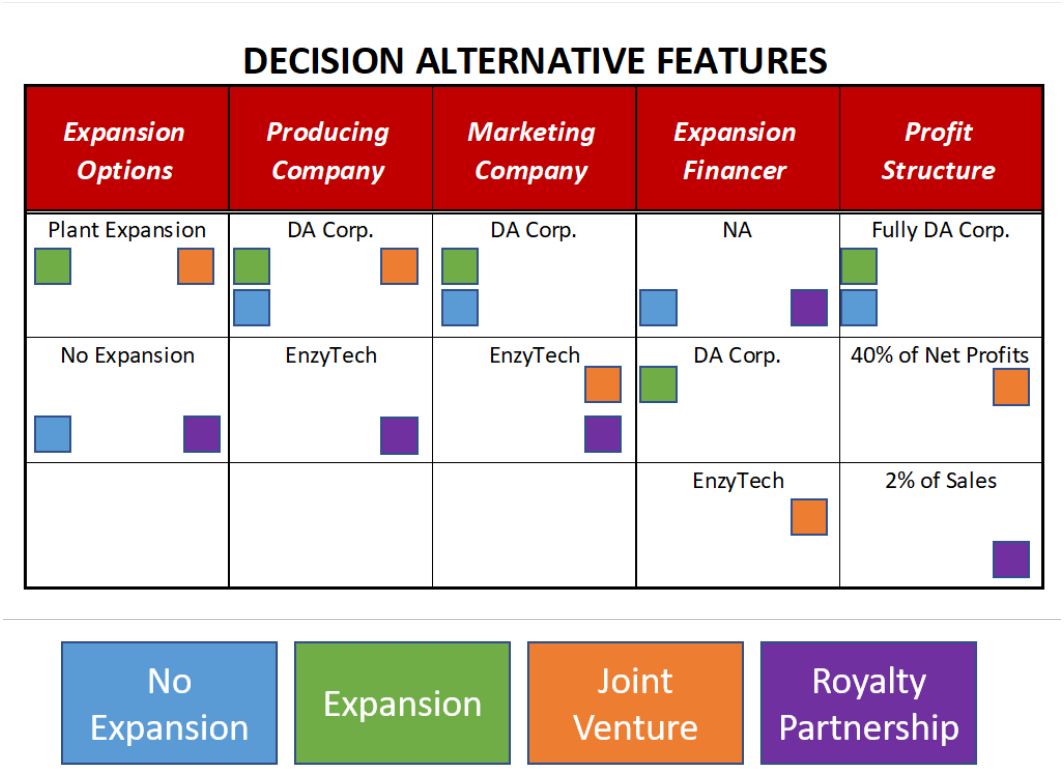


Figure 2.1: Strategy table outlining design alternative features selected for each decision alternative. Color coding of the decision alternatives indicate which feature option was selected for that particular feature

In the strategy table, we see what features different decision alternatives share and what features are differentiating. Expansion only occurs under the expansion and joint venture alternatives. If the expansion

is through the joint venture, EnzyTech will cover the cost instead of DA Corp. DA Corp is responsible for production in all scenarios except under the royalty partnership. If EnzyTech is involved in the strategy, they will be responsible for marketing. Finally, each of the strategies that involve EnzyTech have different profit structures. This is to say the mechanism by which DA Corp. will profit after teaming up with EnzyTech will depend on which alternative is pursued.

2.2 DECISION DIAGRAM

An influence diagram is presented to highlight the relevance between the decision features, capacity characteristics, sales and demand uncertainties, financial uncertainties, financial constants, and financial metrics.

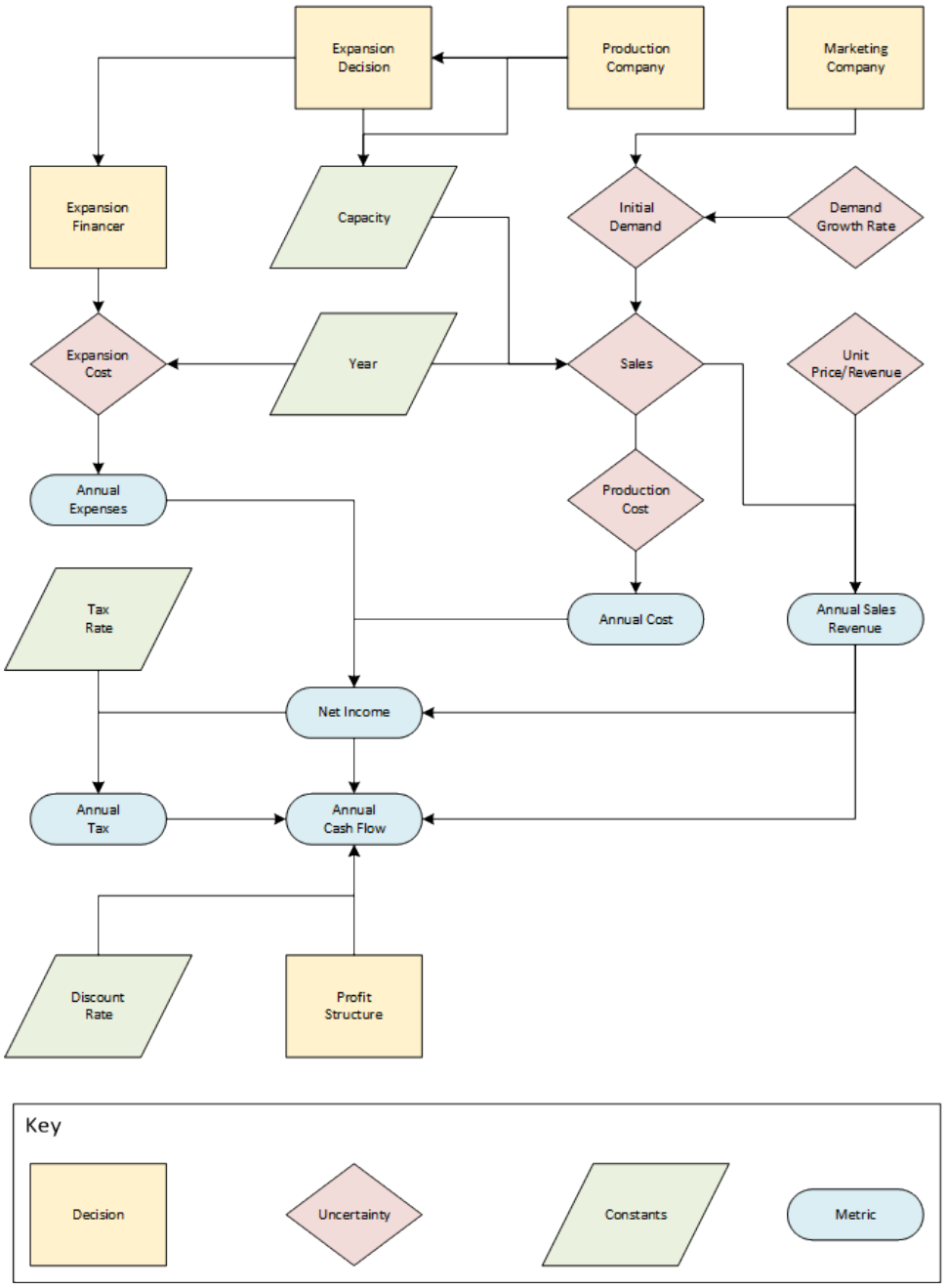


FIGURE 2.2: Influence Diagram of decision problem. Arrows indicate relevance between the included characteristics

In the influence diagram, we can clearly see the various aspects associated with the decision faced by DA Corp. We can also clearly identify where uncertainty exists, what the relevant financial metrics are, and constants that will influence our final determination of cash flow.

3 Evaluation: Deterministic Analysis

A deterministic analysis of the decision alternatives is performed first. A spreadsheet model is developed to assist in understanding deterministic outcomes of all decision alternatives. Using this tool, we perform a deterministic sensitivity analysis to compare the base case scenarios with the extreme case scenarios (best case and worst case scenarios for each decision alternative). We then use tornado diagrams to display a one way sensitivity analysis for each uncertain parameter.

In the deterministic analysis, we consider the 10-50-90 (Low-Base-High) points for all uncertain values. These points were assessed via a meeting with DA Corp.'s top management. The outcomes of the assessment are presented in the table below.

UNCERTAINTY ASSESSMENT

Distinction	Units	Low (10%)	Base (50%)	High (90%)
Initial Demand				
DA Corp. Markets	Million Units / Year	1	2.5	5.5
EnzyTech Market Multiplier	unitless	1.3	1.6	1.8
Demand Growth Rate	% / Year	-0.05%	0.07%	0.09%
Revenue	$ / Unit	9.75	10.75	11.5
Production Cost	$ / Unit	9.25	9.5	9.75
Expansion Cost	$ million	13	14.5	17

TABLE 3.1: Low-Base-High values assessed from top management at DA Corp.

3.1 SPREADSHEET MODEL

A spreadsheet model has been developed to perform deterministic analysis on the decision alternatives. The entire tool is attached to this report. Here we will explain the sections of the tool and how it is to be used. In all sections of the tool, only cells highlighted in blue should be modified.

In the first section of the tool, ***Strategy Selection***, the user selects the decision alternative of interest for analysis. The decisions are indexed 1 through 4 and specified within the tool.

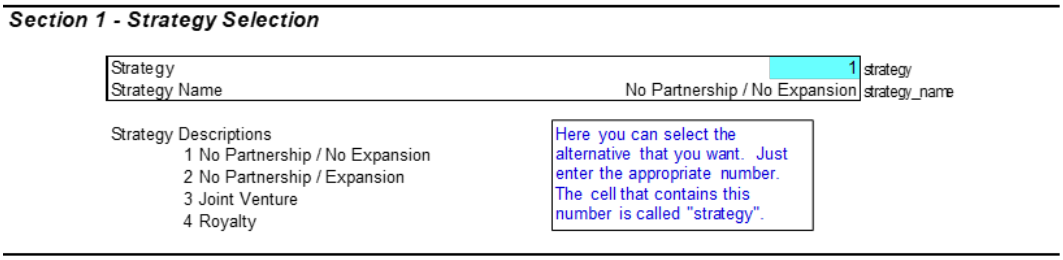


FIGURE 3.1: Section 1 of Spreadsheet Model

The second section of the tool, ***Constants***, is for the inclusion of financially relevant constants for our assessment. In this assessment, we consider a discount rate when evaluating future monetary values and a tax rate applied to net income. While we have these values fixed in our analysis, they can be adjusted if their values are assessed to be different.

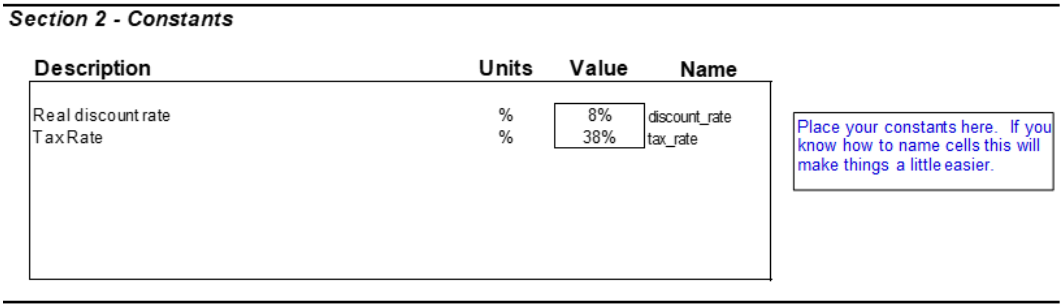


FIGURE 3.2: Section 2 of Spreadsheet Model

Section three of the tool, ***Uncertainties***, is where the user can specify which of the deterministic values for each uncertain parameter should be applied. Values are indexed and limited to the Low-Base-High values from the assessment performed with DA Corp. management team. For the analysis, Low-Base-High values can be modified if a new assessment is performed and the values in the tool no longer align with the beliefs of management.

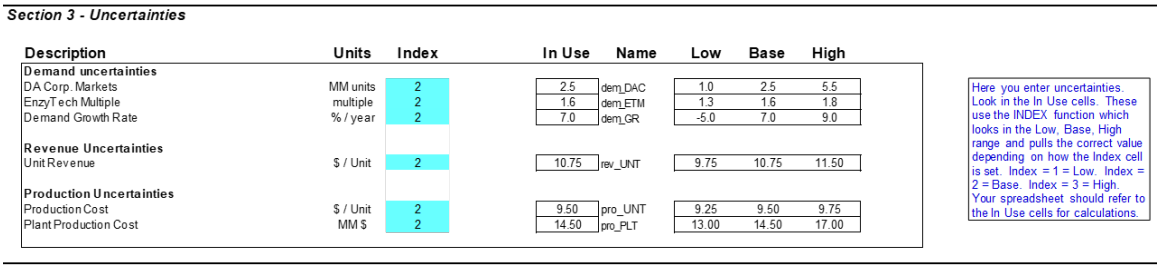


FIGURE 3.3: Section 3 of Spreadsheet Model

The final section of the tool, ***Calculations***, contains the calculations performed to attain relevant and meaningful financial metrics. Values used in this section of the tool are linked to specific strategies being tested. This is because under different strategies, different criteria apply in terms of production capacity and revenue mechanisms. Full written out equations for these calculations are presented in the appendix.

Section 4 - Calculations

No Partnership / No Expansion

Year		2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Period		0	1	2	3	4	5	6	7	8	9
Sales											
Demand | DA Corp. Markets	MM units	2.50	2.68	2.86	3.06	3.28	3.51	3.75	4.01	4.30	4.60
Demand | EnzyTech Markets	MM units	4.00	4.28	4.58	4.90	5.24	5.61	6.00	6.42	6.87	7.35
Capacity	MM units	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50
Sales	MM units	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50
Revenue	MM $	26.88	26.88	26.88	26.88	26.88	26.88	26.88	26.88	26.88	26.88
Production Cost	MM $	23.75	23.75	23.75	23.75	23.75	23.75	23.75	23.75	23.75	23.75
Plant Cost	MM $	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
JV Payment	MM $	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Royalty Payment	MM $	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Earnings Before Tax	MM $	3.13	3.13	3.13	3.13	3.13	3.13	3.13	3.13	3.13	3.13
Taxes	MM $	1.19	1.19	1.19	1.19	1.19	1.19	1.19	1.19	1.19	1.19
Tax Credit Available for Next Year	MM $	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tax Payment	MM $	1.19	1.19	1.19	1.19	1.19	1.19	1.19	1.19	1.19	1.19
Cash Flow	MM$	**$1.94**	**$1.94**	**$1.94**	**$1.94**	**$1.94**	**$1.94**	**$1.94**	**$1.94**	**$1.94**	**$1.94**
Present Equivalent	MM 2020 $	1.94	1.79	1.66	1.54	1.42	1.32	1.22	1.13	1.05	0.97
Cumulative Earnings	MM 2020 $	$ 14.04									

You should complete this calculation section. We have provide one equation for you. It should give you all the logical statements you might need.

FIGURE 3.4: Section 4 of Spreadsheet Model

This deterministic analysis spreadsheet model is used for all the deterministic sensitivity analysis presented in this report.

3.2 EXTREME CASE SENSITIVITY ANALYSIS

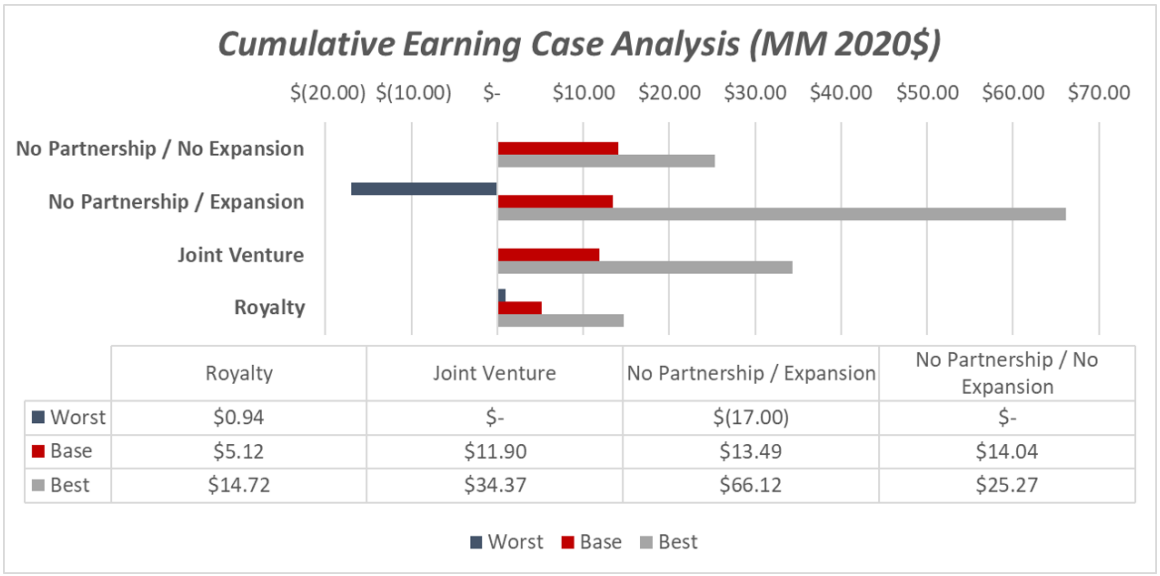
In the extreme case sensitivity analysis, we are interested in comparing the base case scenario for each policy with the best and worst case scenario for each policy. Using the deterministic values, we select a high or low assessment for each uncertain parameters. Based on the formulation of the cumulative earnings (outcome value of our decision problem), we can intuitively determine what would be the best and worst case scenarios. In the table below, we outline which Low-Base-High values are used for each parameter that, collectively, define the 3 scenarios of interest.

SCENARIOS

	Worst Case	*Base Case*	*Best Case*
DA Corp. Markets	Low	Base	High
EnzyTech Multiple	Low	Base	High
Demand Growth Rate	Low	Base	High
Unit Revenue	Low	Base	High
Production Cost	High	Base	Low
Plant Production Cost	High	Base	Low

TABLE 3.2: Low-Base-High values for each parameters associated with the base case and 2 extreme cases (best and worst)

Note that the worst case scenario is is not when all uncertainties are at the low, and the best case scenario is not when all uncertainties are at a high. While lower demand, demand multiplier, demand growth rate, and unit revenue result in lower cumulative earnings, the same is not true for production costs and plant production costs. Higher production costs and higher plant production costs result in lower cumulative earnings. Based on the nature by which cumulative earnings is calculated, we know that within the confines of the Low-Base-High assessment, these are the best and worst case scenarios.



	Royalty	Joint Venture	No Partnership / Expansion	No Partnership / No Expansion
Worst	$0.94	$-	$(17.00)	$-
Base	$5.12	$11.90	$13.49	$14.04
Best	$14.72	$34.37	$66.12	$25.27

FIGURE 3.5: Extreme Case Sensitivity Analysis

In the figure above, we plot our findings for the above scenarios for all 4 decision alternatives. The No Partnership / Expansion policy has the most negative outcome under the worst case scenario while the No Partnership / No Expansion and Joint Venture alternatives yield a cumulative earnings of zero. The cumulative earnings for the Royalty alternative in the worst case scenario is positive, but very small.

Under the base case, it appears that the not forming a partnership yields higher cumulative earnings than either the Joint Venture or Royalty routes. The Royalty route has the lowest cumulative earnings.

In the best case scenario, the No Partnership / Expansion policy overwhelmingly outperforms the other alternatives. Recall that this policy also had the worst outcome under the worst case scenario. The No Partnership alternative has the widest range for cumulative earnings. Note that these assessments are deterministic and solely using the assessed Low-Base-High values from DA Corp.

3.3 ONE-WAY SENSITIVITY ANALYSIS: TORNADO DIAGRAMS

To further assess the impact of uncertain values in our assessment, we perform a one way sensitivity analysis for for each decision alternative. In the one way sensitivity analysis, we hold all uncertainties constant at the base case except for the uncertainty being assessed. We determine the cumulative earnings if this value is at the low or high value and present the the cumulative earnings under this scenario. Outcomes are quantified in terms of cumulative earnings. The spreadsheet model is used to determine all values which are presented in a table format in the appendix. We present our findings via tornado diagrams that are centered at the base case.

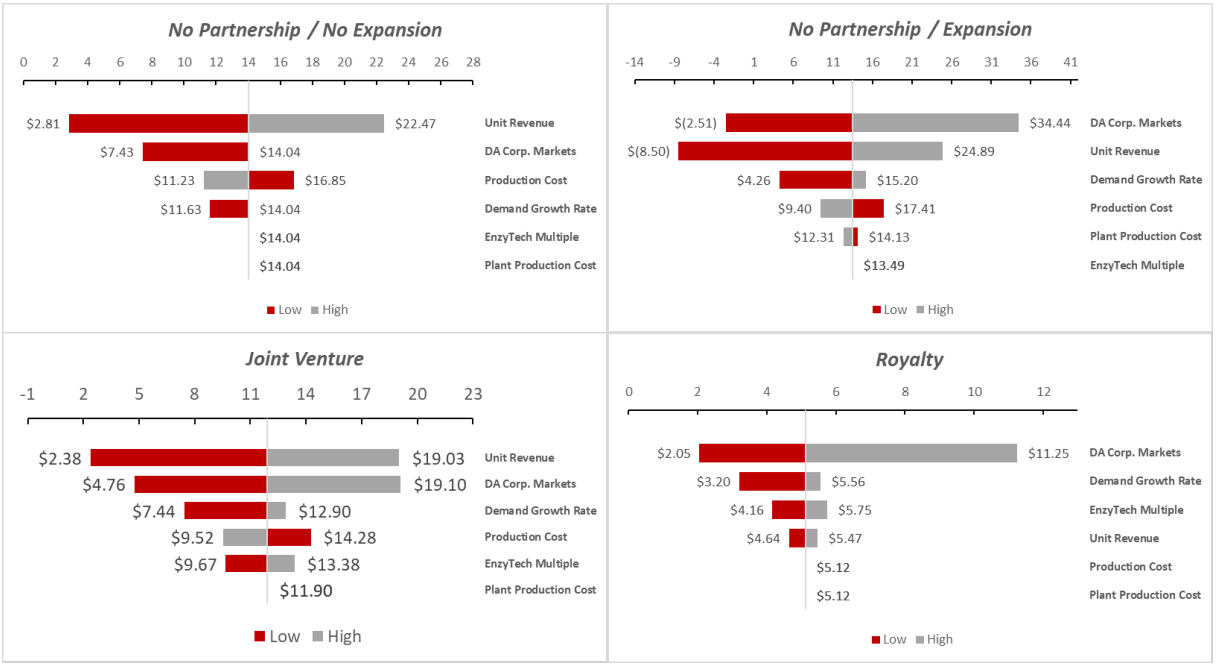


FIGURE 3.6: Tornado diagrams representing a one-way sensitivity analysis. Base case cumulative earnings for each alternative is as follows: No Partnership / No Expansion ($14.04), No Partnership / Expansion ($13.49), Joint Venture ($11.90), Royalty ($5.12)

The no partnership / No Expansion alternative is most sensitive to the per unit revenue, and least sensitive to the demand growth rate. The EnzyTech marketing multiplier and plant production cost have no impact on this alternative.

For the No Partnership / Expansion alternative, cumulative earnings are highly sensitive to the success of DA Corp. marketing and the per unit revenue. A deviation to higher marketing outcomes from the base case will have more impact than if the lower level occurs. The opposite is true for unit revenue.

A Joint Venture is most sensitive to per unit revenue and DA. Corp. marketing outcome.Attaining the high in either of these will result in similar cumulative earnings, but a low for per unit revenue will result in a noticeably lower cumulative earnings.

Last, the Royalty alternative is most sensitive to the DA Corp. marketing outcome. Essentially, this means that demand is the primary driver of outcomes. For all other uncertainties, the high value generates only marginal increases in the cumulative earnings while the low values would can have comparatively larger effects.

4 Evaluation: Probabilistic Analysis

The deterministic analysis allowed us to estimate the outcomes for each decision alternative as well as approximate a range around these outcomes based on Low-Base-High values. While this deterministic sensitivity analysis is effective as a preliminary analysis, further insight is attained by performing a probabilistic analysis. A follow up assessment was performed with DA Corp. to generate a cumulative distribution function for each uncertainty faced in this decision process. All uncertainty cumulative distribution functions are modeled using beta functions. In the table below, We present the min, max, alpha, and beta parameters used to define each uncertainty CDF. Graphs of the CDFs can be found in the appendix.

We first present the decision tree associated with this decision problem, highlighting which uncertainties are relevant for each alternative. We use a Monte Carlo analysis to determine the expected cumulative earnings as well as expected utility for each alternative. DA Corp. was assessed to operate under the delta property and have a risk tolerance of $30 million, so an exponential u-curve function was applied. Outcomes from the Monte Carlo analysis are presented as histograms to showcase the distribution of outcomes simulated.

BETA DISTRIBUTION PARAMETERS

Distinction	Units	Range	Alpha	Beta
Initial Demand				
DA Corp. Markets	Million Units / Year	[0, 9]	1.9	3.6
EnzyTech Market Multiplier	unitless	[0.5, 2.5]	3.85	0.032
Demand Growth Rate	% / Year	[-12, 24]	4.45	5.8
Revenue	$ / Unit	[9, 12]	3.75	3
Production Cost	$ / Unit	[9, 10]	2.9	3
Expansion Cost	$ million	[12, 19]	4.75	7

TABLE 4.1: Beta distribution parameters for uncertain values

4.1 DECISION TREE

The decision tree presented shows the decision alternatives, prospects, defined by 2 main decisions: (1) Partnership or no partnership (2) Expansion or no expansion. For each prospect, we identify which uncertainties would need to be considered when assessing the cash flow and cumulative earnings for DA Corp. Not that under each prospect, a different set of uncertainties must be considered. The layout of the decision tree is used to help us build the numerical model that will be used for the Monte Carlo Analysis.

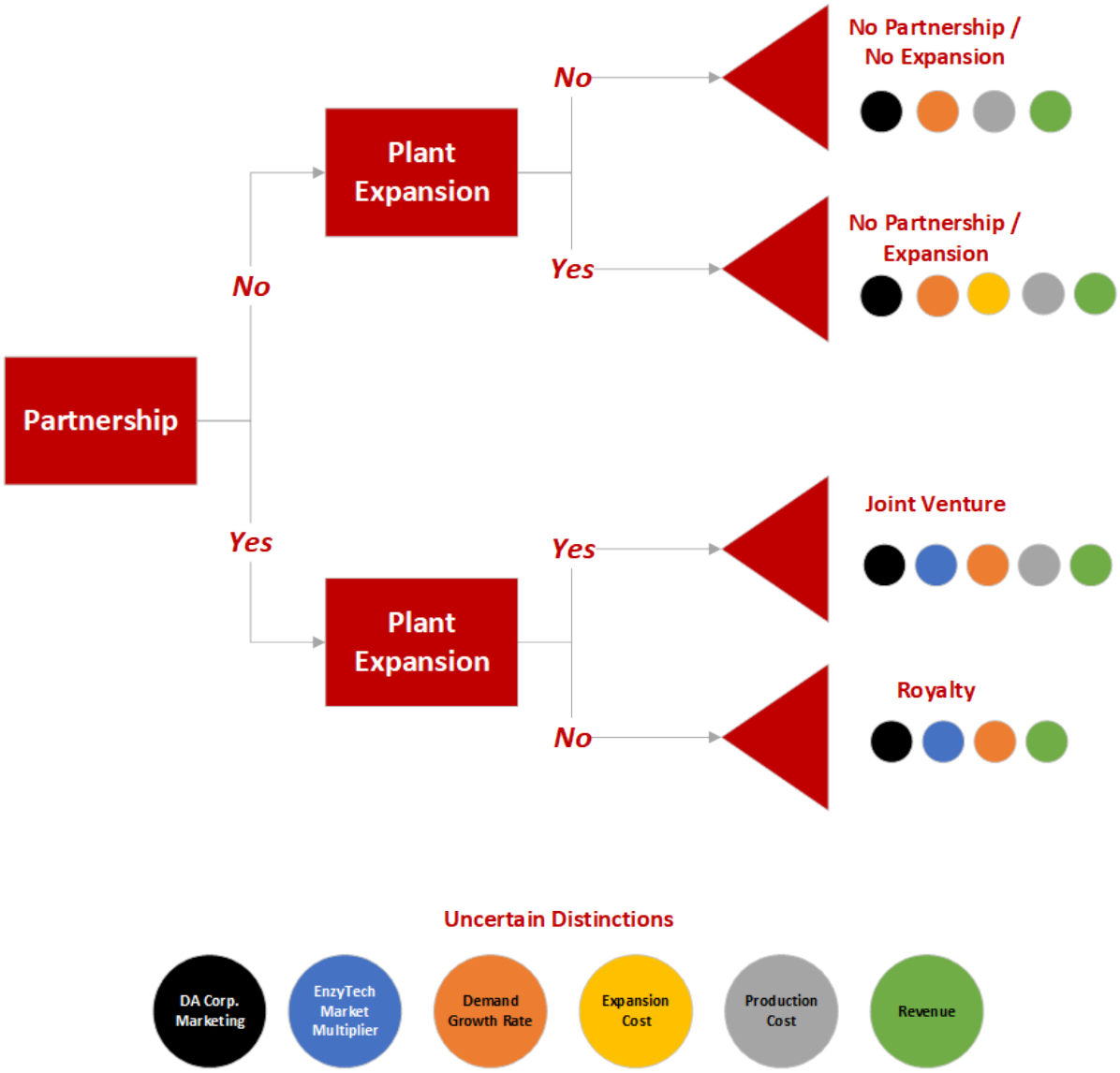


FIGURE 4.1: Decision Tree

4.2 MONTE CARLO ANALYSIS

The deterministic spreadsheet model is is modified to incorporate random values following the previously described beta distributions for the uncertain parameters, as opposed to the deterministic Low-Base-High values. Expected net cumulative earnings and expected u-values are determined for each alternative. Having identified DA Corp. as following the delta property, a simple exponential u-curve function is utilized with a risk tolerance of $30 million (as shown in the appendix). 15,000 iterations are used for this Monte Carlo analysis. We present the findings of the Monte Carlo analysis as a series of histograms. Not that the axis are not identical across histograms.

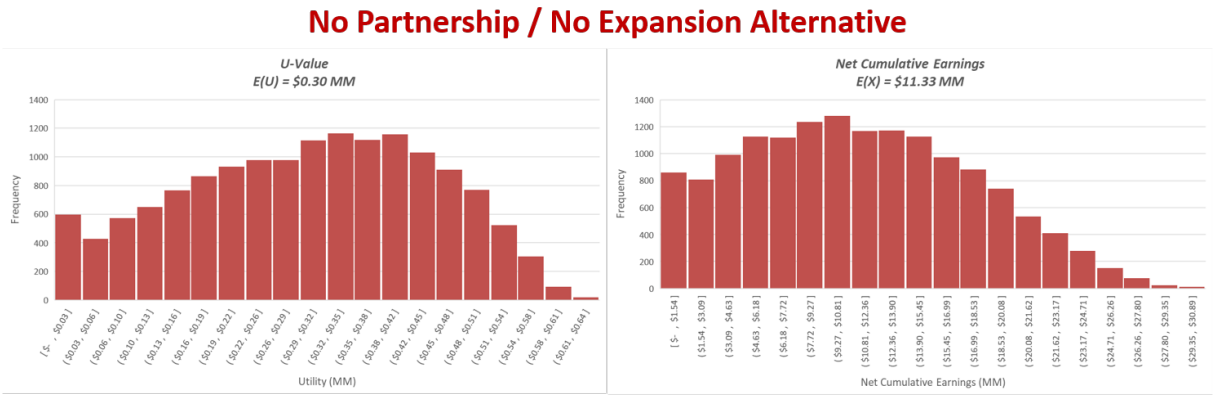


FIGURE 4.2: Histogram of U-value and Net Cumulative Earnings for no partnership / no expansion alternative

Under the no partnership no expansion alternative, we see a generally normal distribution for both the u-value and net cumulative earnings graphs. The net cumulative earnings graphs has a slight skew right that can drive up the expected net cumulative earnings.

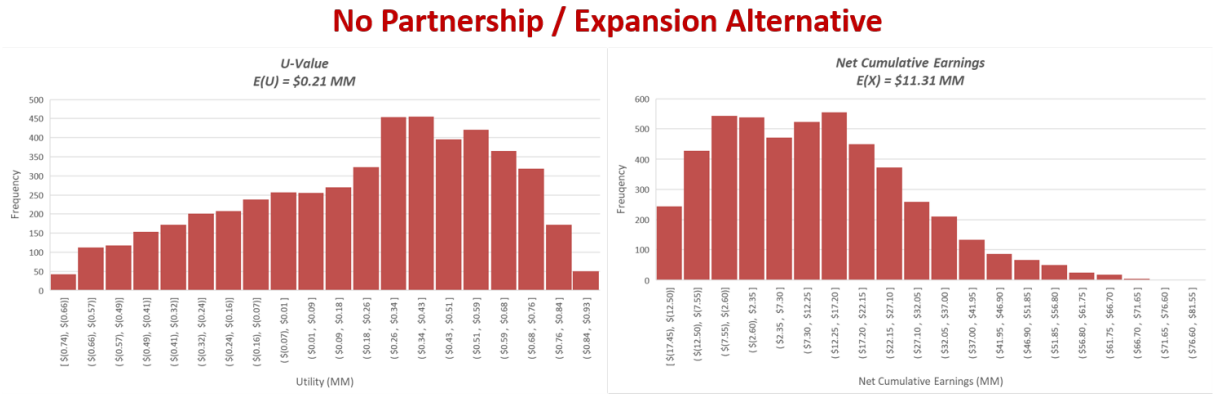


FIGURE 4.3: Histogram of U-value and Net Cumulative Earnings for the no partnership / expansion alternative

With no partnership and expansion alternative, we see a left skewed distribution for the u-value plot and a right skewed distribution for the net cumulative earnings. As mentioned before, the skew can impact the expected values. Cumulative earnings are approximately the same under both no partnership alternatives, but the utility is higher if the no expansion decision is made.

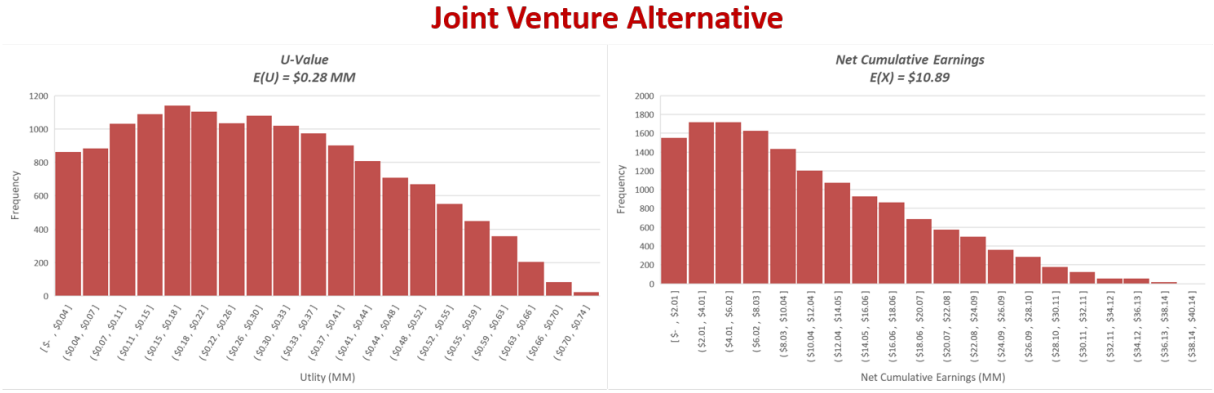


FIGURE 4.4: Histogram of U-value and Net Cumulative Earnings for the joint venture alternative

The joint venture results in the u-value distribution having a slight skew right while and the the net cumulative earnings distribution has a strong skew right. Net cumulative earnings are lower than both no partnership routes, but the utility is comparable to no partnership and no expansion.

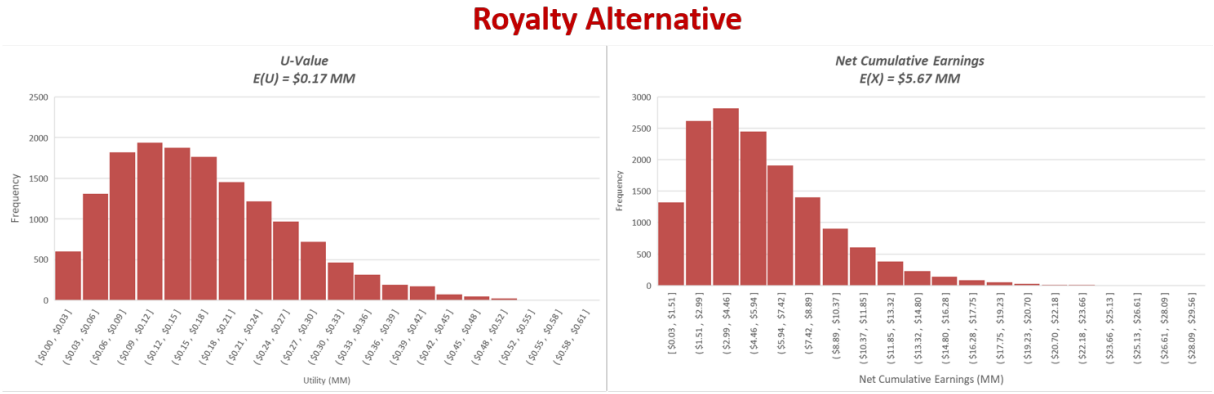


FIGURE 4.5: Histogram of U-value and Net Cumulative Earnings for the royalty alternative

Under the royalty route, both u-value and net cumulative earning distributions show noticeable skews right. Additional, the expected u-value and expected net cumulative earnings are both noticeably lower than the other alternatives.

Through the Monte Carlo Probabilistic Analysis, we identify the no partnership and no expansion alternative as having the highest expected u-value and highest net cumulative earnings.

5 Appraisal

Towards assessing the the robustness and quality of our findings, we present a formal appraisal of the analysis performed. In this section, sensitivity analysis is done on the risk tolerance of DA Corp. and the annual discount rate. The goal of the sensitivity analysis is to see if the preferred model changes if the fixed parameter of interest is different than what was initially assessed. A spider chart is then used to present what aspects of this decision analysis are the strengths, and where are the weaknesses. This helps to inform what steps can and/or should be taken in the next iteration of the decision analysis cycle.

5.1 Sensitivity Analysis

In order to evaluate the sensitivity of the above results that were generated according to our Monte Carlo analysis, we performed sensitivity analysis on the expected u-value with respect to both discount rate and risk aversion. These values are set as fixed in our prior analysis, but we recognize that they can easily change over time. Note that expected u-value is used instead of expected cash flow. These results are shown below.

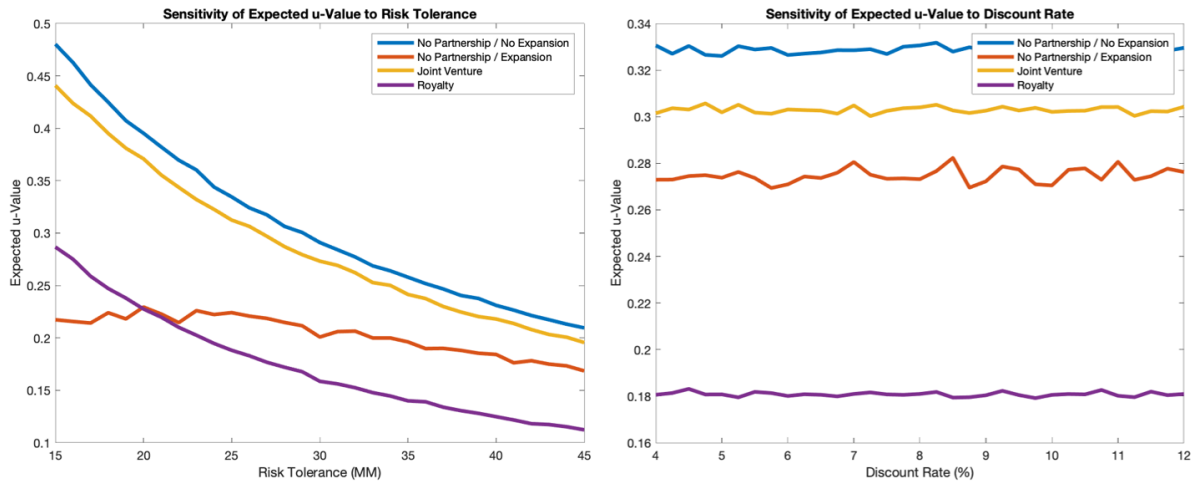


Figure 5.1: Expected u-value of each alternative with respect to risk tolerance and discount rate

It can be seen that small changes in risk tolerance (over the range of $\$15MM - \$45MM$) do not alter the order of the top two alternatives: No Partnership / No Expansion and No Partnership / Expansion. However at lower values of risk tolerance, the proposed order of preference for the Joint Venture and Royalty options does, in fact flip. This is only relevant in the case where the top two options are eliminated. An example of this would be if higher authority stakeholders are forcing some type of partnership to be formed for reasons beyond cash flow. We also recognize that it is possible that more trends exist beyond the risk tolerance range that was assessed. For changes in discount rate (within the range of $4\% - 12\%$), we do not observe any changes in the ordering of decision alternatives.

5.2 DECISION QUALITY

Decision quality is assessed under 6 criteria: (1) Reliable information, (2) Clear preferences, (3) Correct logic, (4) Commitment to action, (5) Appropriate frame, and (6) Creative alternatives. For each criteria, we assign a percentage from 0% to 100% where 100% indicates that further improvement would be uneconomical. Below we graphically present the information via a spider chart and provide general justifications for our percent assignment. Note that the decision quality diagram presented is only a reflection of the first iteration of analysis. Per continued feedback with DA Corp., additional considerations will be made that will allows us to improve on decision quality in our assessment for the company.

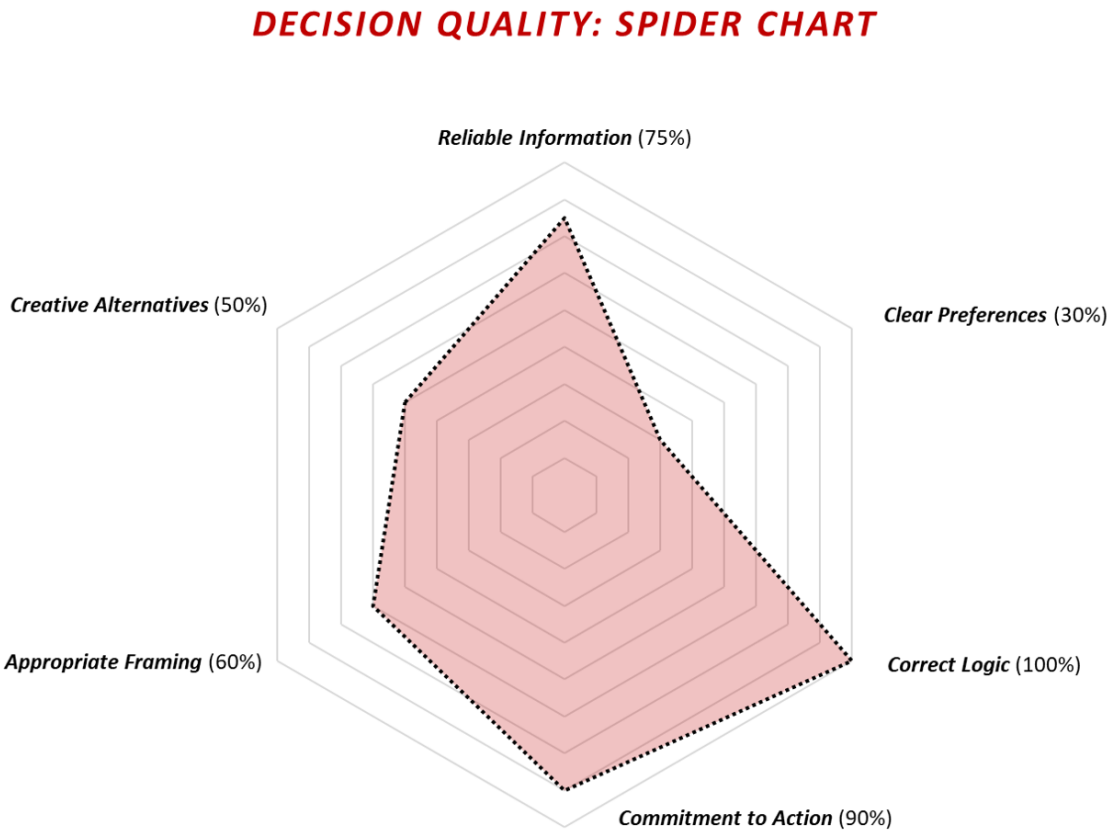


FIGURE 5.2: Spider/Radar chart for decision quality assessment

1. **Reliable Information (75%)**: We assess reliability of information based on the uncertain distinctions. There were 6 uncertainty distinctions, all of which were assessed directly from DA Corp. We are confident in DA Corp.'s ability to assess revenue per unit, production costs, and expansion costs. However, because DA Corp. does not have experience with marketing, there can likely be improvements to the two initial demand assessments and even the demand growth rate (which could in theory be impacted by marketing strategy).
2. **Clear Preferences (30%)**: In this analysis, we are strictly looking at the monetary cash flow between different alternatives. No assessment was done with DA Corp. regarding their preferences for the differences alternatives. Incorporating preferences would allow us to consider the factors that may influence the the course of action for DA Corp that are not directly related to cash flow. The only consideration for preferences is that more money is preferred to less.
3. **Correct Logic (90%)**: We are confident in the reasoning used in our decision analysis. The

numerical calculation for cash flow is accurate with the inclusion of factors such as tax and discount. We further consider extreme case scenarios in our model. As an example, we say that DA Corp. would not product the enzyme if the revenue per unit is higher than the per unit production cost. We consider uncertainty on most parameters, and perform sensitivity analysis on parameters that were taking as exact values. There is one assumption that is made that we believe may be worth further exploring. In the analysis, demand growth rate is independent of who does marketing. We believe this may not be appropriate, or that some uncertainty around this value may be necessary.

4. **Commitment to action (80%)**: While we have worked closely with DA Corp. in our assessments, we did not work with EnzyTech, the partner that would be involved in two of the alternatives. The absence of EnzyTech from discussions of the assessment means that their commitment to action, if one of the partnership alternatives is selected, could be in question. However, considering the status of EnzyTech in the industry, we remain confident they will act in agreement per their prior discussions with DA Corp.

5. **Appropriate Frame (60%)**: Two major assumptions are made in the framing. First, an assumption is made regarding the process being used and second, an assumption is made that Cyclone will not be stacked with other enzymes being designed. These assumptions can have significant impact on uncertain values relating to demand, production costs, and per unit revenue. The framing is relatively appropriate as a first pass, but it may be an oversimplification of what may realistically occur and multiple iterations of this decision analysis cycle should be performed.

6. **Creative Alternatives (50%)**: A variety of alternatives have not been explored that should be considered. As an example, hybrid alternatives involving a royalty and a varying level of financial support in the joint venture could be explored. Joint ventures or royalty partnerships with multiple companies can also create a multitude of possibilities.

The three areas we suggest focusing on moving forward are appropriate framing, clear preferences, and creative alternatives. We feel the framing may have generated an oversimplified decision. The main framing piece that can lead to significantly different outcomes is the assumption that Cyclone will not be "stacked" with other products in the portfolio. Is it common in the industry for this to be the case? If not, how significantly can being "stacked" impact the demand, and does this depend on what other enzymes it is stacked with? Further, this can have major implications on production capacity. It will be important to expand our frame in next iterations.

With regards to clear preferences, an assessment should be done to try and capture the non-monetary preferences for each of the proposed alternatives. Perhaps an expansion or partnership results in reallocation of labor that is undesired. Another possibility is that by implementing changes to the current workflow of DA Corp, they will experience unexpected inefficiencies or expose themselves to unanticipated risks. These are just examples of reasons why DA Corp. might prefer one alternative over another if we excluded the cash flow metric.

Last, we propose that new alternatives are explored that may be hybridization's of the current alternatives. We also encourage looking at more partners beyond EnzyTech, or even multiple partners. We feel the 4 alternatives proposed are not an exhausted search of the options available to DA Corp.

6 Decide

Extensive interviews with management teams at Daylight Alchemy Corporation enabled us to assess the companies risk tolerance and belief towards uncertainties relevant towards production and marketing of Cyclone Enzyme. From the information collected, deterministic and probabilistic models were developed for the four decision alternatives proposed by DA Corp.

While the deterministic model could provide valuable insight towards the range of attainable outcomes under various Low-Base-High conditions, the more comprehensive probabilistic model considers all uncertainties simultaneously. In the probabilistic model, simulations are conducted on the order of hundreds of thousands to better assess expected outcomes. Based on this model, the range of all potential outcomes was assessed for each decision prospect, and the expected u-value to the company of each of these distributions was determined.

The deterministic model shows that under the base case scenario, the No Partnership / Expansion and No Partnership No/Expansion can lead to similar cumulative earnings over the 10 year assessment period. We also find that the No Partnership / Expansion policy can definitively lead to the best outcome in the best case scenario, and worst outcome in the worst case scenario. This is primarily driven by the uncertainty in DA Corp. marketing and uncertainty in unit revenue. Joint venture has the second highest best case scenario outcome and the royalty option has the only positive worst case scenario outcome. From the deterministic assessment, it is hard recommend a single course of action.

From the probabilistic analysis, we find that No Partnership / No Expansion alternative has the highest expected u-value and highest expected net cash. The appropriate course of action based on the Monte Carlo analysis would be for Daylight Alchemy Corporation to avoid expanding its manufacturing facility, and not partner with EnzyTech. Beyond the monetary advantage, we want to additionally highlight this course of action involves the fewest number of moving parts / unknowns. As the simplest of the decision prospects, this course of action minimizes DA Corp.'s exposure to risks such as natural disasters, global market events, and other unseen events. It should be noted that we would have recommended this course of action even if it did include a greater number of unknown variables than the alternative prospects as long as the expected u-value and expected net cumulative earnings remains higher the highest.

As always, Nguyen, Decker, and Associates is available to discuss the implications of this recommendation, explain the methodology employed here in greater detail, and update this analysis in the event of changing situations or new information.

7 Appendix

7.1 Sensitivity Analysis Data (Deterministic Range Analysis)

EXTREME CASE SENSITIVITY DATA

Scenario	No Partnership / No Expansion	No Partnership / Expansion	Joint Venture	Royalty
Worst Case	$ 14.04	$ 13.49	$ 11.90	$ 5.12
Base Case	$ -	$ (17.00)	$ -	$ 0.94
Best Case	$ 25.27	$ 66.12	$ 34.37	$ 14.72

Figure 7.1: Extreme Case Sensitivity

ONE WAY SENSITIVITY DATA

	No Partnership / No Expansion					No Partnership / Expansion			
	Low	Base	High	Max Spread		Low	Base	High	Max Spread
No Partnership Alternatives	$ 7.43	$ 14.04	$ 14.04	$ 6.61	*DA Corp. Markets*	$ (2.51)	$ 13.49	$ 34.44	$ 36.95
	$ 14.04	$ 14.04	$ 14.04	$ -	*EnzyTech Multiple*	$ 13.49	$ 13.49	$ 13.49	$ -
	$ 11.63	$ 14.04	$ 14.04	$ 2.41	*Demand Growth Rate*	$ 4.26	$ 13.49	$ 15.20	$ 10.94
	$ 2.81	$ 14.04	$ 22.47	$ 19.66	*Unit Revenue*	$ (8.50)	$ 13.49	$ 24.89	$ 33.39
	$ 16.85	$ 14.04	$ 11.23	$ 5.62	*Production Cost*	$ 17.41	$ 13.49	$ 9.40	$ 8.01
	$ 14.04	$ 14.04	$ 14.04	$ -	*Plant Production Cost*	$ 14.13	$ 13.49	$ 12.31	$ 1.82
	Joint Venture					Royalty			
	Low	Base	High	Max Spread		Low	Base	High	Max Spread
Partnership Alternatives	$ 4.76	$ 11.90	$ 19.10	$ 14.34	*DA Corp. Markets*	$ 2.05	$ 5.12	$ 11.25	$ 9.20
	$ 9.67	$ 11.90	$ 13.38	$ 3.71	*EnzyTech Multiple*	$ 4.16	$ 5.12	$ 5.75	$ 1.59
	$ 7.44	$ 11.90	$ 12.90	$ 5.46	*Demand Growth Rate*	$ 3.20	$ 5.12	$ 5.56	$ 2.36
	$ 2.38	$ 11.90	$ 19.03	$ 16.65	*Unit Revenue*	$ 4.64	$ 5.12	$ 5.47	$ 0.83
	$ 14.28	$ 11.90	$ 9.52	$ 4.76	*Production Cost*	$ 5.12	$ 5.12	$ 5.12	$ -
	$ 11.90	$ 11.90	$ 11.90	$ -	*Plant Production Cost*	$ 5.12	$ 5.12	$ 5.12	$ -

Figure 7.2: One Way Sensitivity

7.2 Equations used for Analysis

Earnings Before Tax Equation

- EBT = Earnings Before Tax
- REV = Revenue
- CoGS = Cost of Goods Sold
- PC = Plant Cost
- JVP = Joint Venture Payment
- RP = Royalty Payment

$$EBT = REV - CoGS - PC - JVP - RP \tag{7.1}$$

Present Equivalent Equation

- FV = Future Value of Money
- PV = Present Value of Money
- R = Discount Rate
- n = Number of Years

$$PV = \frac{FV}{(1+R)^n} \tag{7.2}$$

u-Curve Equation

- u = u-value
- λ = Risk Tolerance
- NIAT = Net Income After Taxes

$$u = 1 - e^{\frac{1}{\lambda}NIAT} \tag{7.3}$$

7.3 BETA CDF FOR UNCERTAIN VALUES

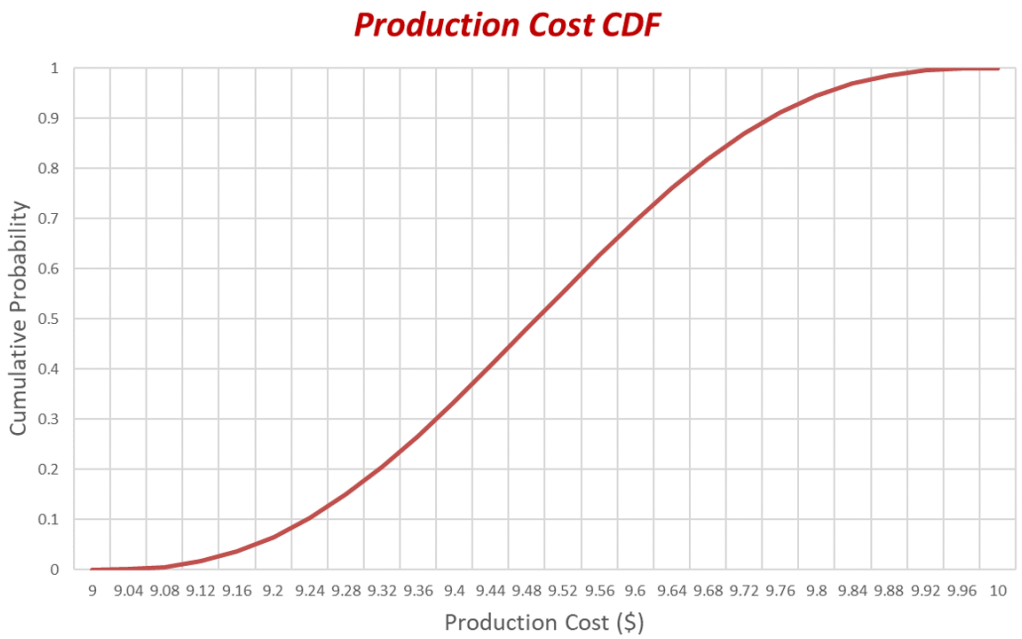


FIGURE 7.3: Production Cost Beta CDF

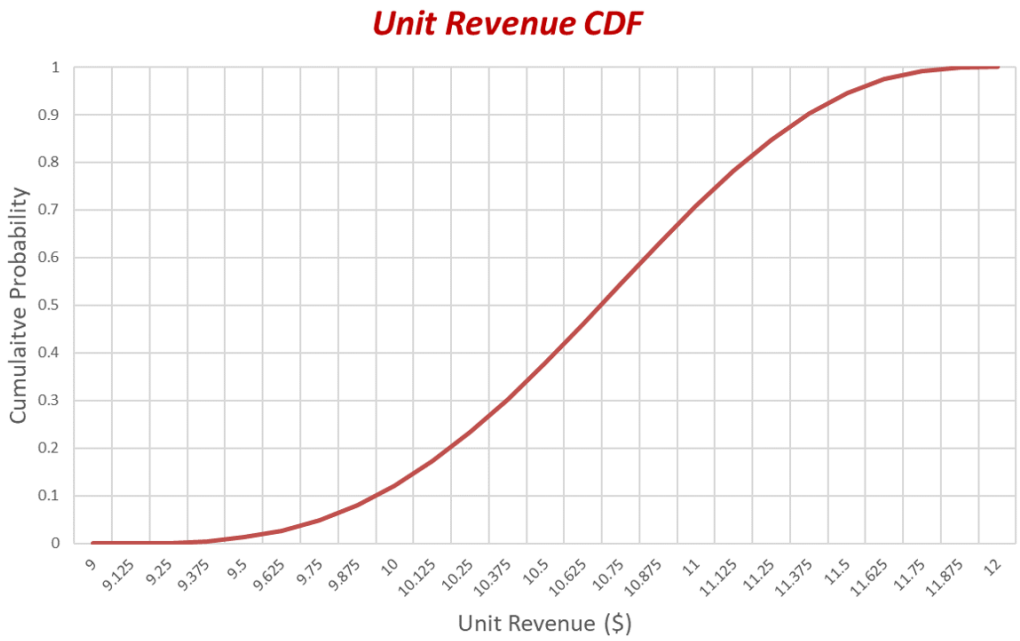


FIGURE 7.4: Unit Revenue Beta CDF

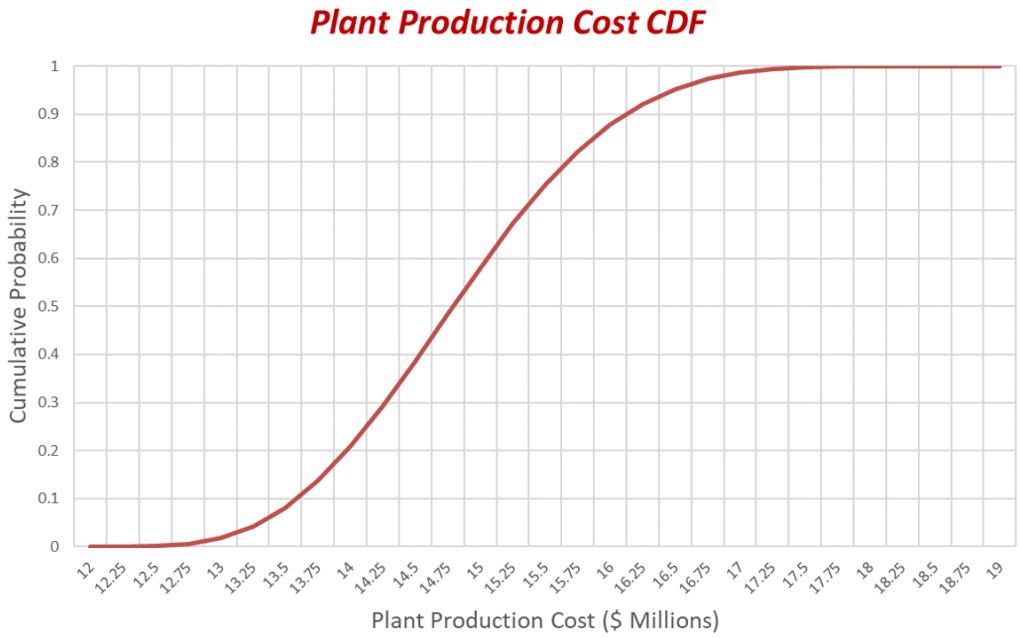


FIGURE 7.5: Plant Production Cost Beta CDF

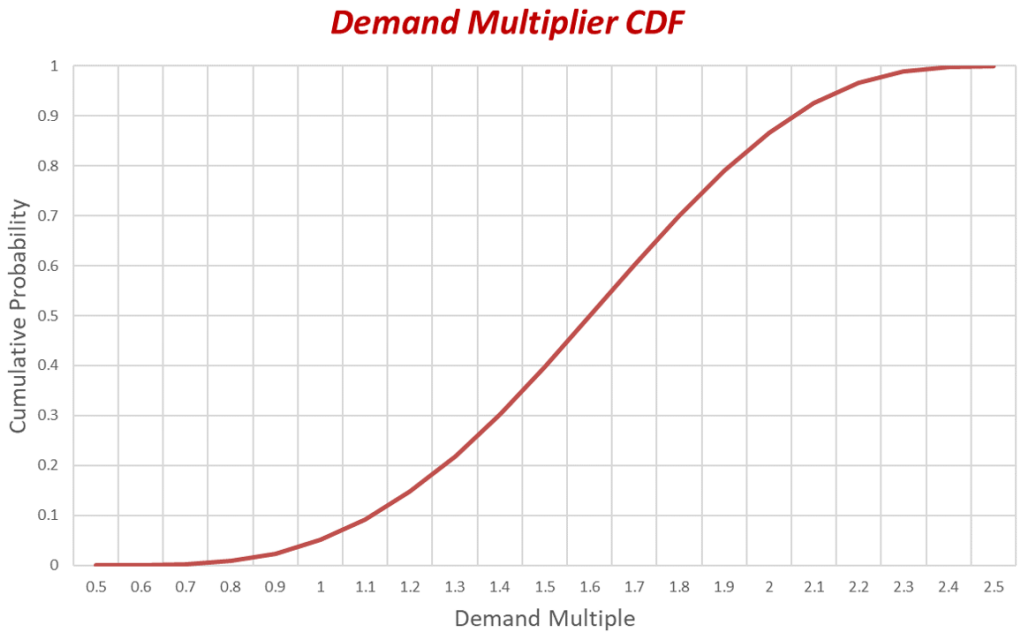


FIGURE 7.6: Demand Multiplier Beta CDF

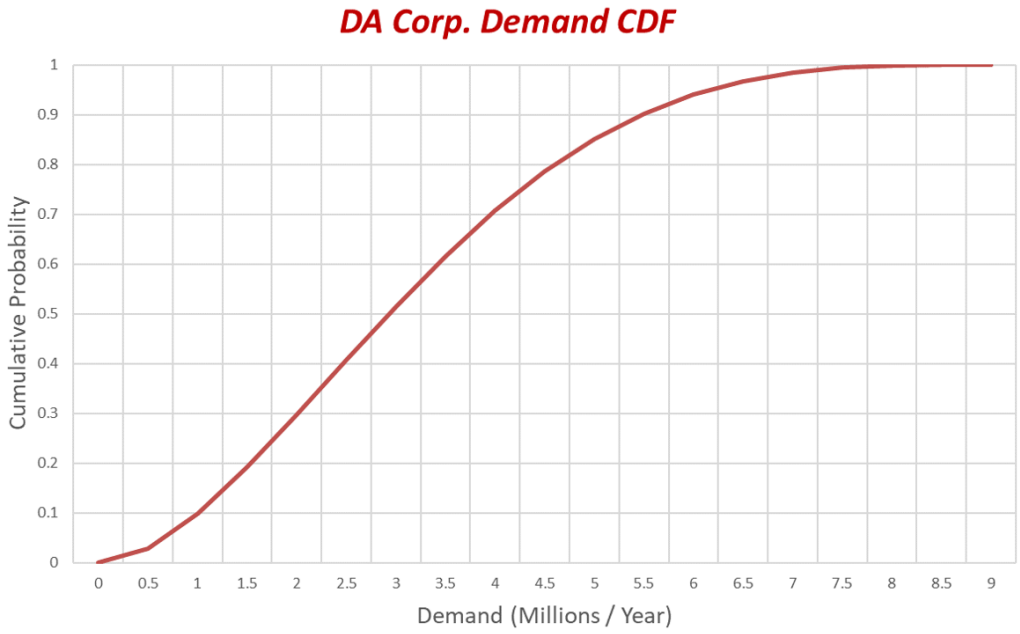


FIGURE 7.7: DA Crop. Demand Beta CDF

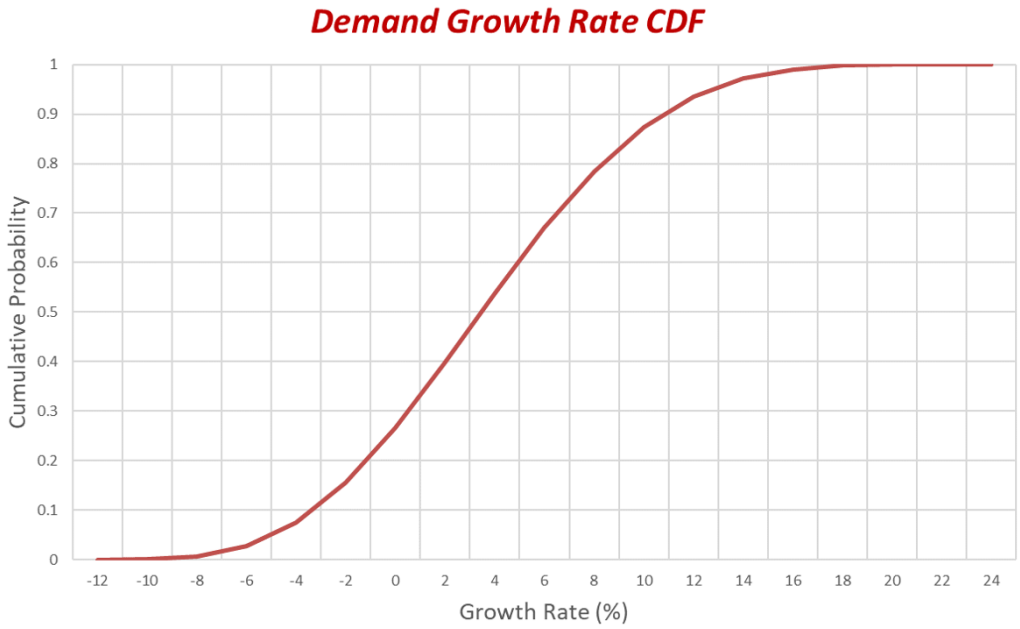


FIGURE 7.8: Demand Growth Rate Beta CDF