

Daylight Alchemy Corporation

Decision Analysis Case Study

GE 450

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EXECUTIVE SUMMARY

The decision situation of Daylight Alchemy Corporation in marketing and producing the Cyclone enzymes was analyzed using a structured approach. The case was taken through one iteration of the decision analysis cycle, which is defined as formulation, evaluation, appraisal, and decision. Various decision tools, such as issue raising, spreadsheet model, decision tree, and sensitivity analysis, were used to conduct the analyses. Four decision alternatives were analyzed: no partnership/no expansion (strategy 1), no partnership/expansion (strategy 2), joint venture with EnzyTech (strategy 3), and royalty partnership with EnzyTech (strategy 4). In addition, NPV was considered as the value measure of the different prospects. The main insights are discussed below. In addition, the report with the full details of the analysis is attached, and the spreadsheet model of the analysis is enclosed.

The following discussion of the main insights is based on the assumption that DA Corp follows the five rules of actional thought and prefers more money to less. In addition, the discussion assumes DA Corp is risk averse and follows the delta property as these were corroborated in the assessment of DA Corp. Cash flows were assumed to occur at the start of the year in the value model, and uncertainties were assumed to be irrelevant with each other.

Strategy 1 is the most profitable and best decision alternative if the problem did not involve uncertainties. The demand if DA Corp. markets for all alternatives and unit revenue for all except strategy 4 were considered to be significant uncertainties. Strategy 1 was also found to be the best decision if uncertainty and risk is considered. The ranking of the alternatives was the same regardless of whether the uncertainties are considered or not.

There is no guarantee that that DA Corp. would be better off with one strategy regardless of the outcome of the strategies. However, DA Corp always prefers strategy 1 over the other strategies, and always prefers strategy 3 over strategy 2. Regarding the prospects and distribution of the decision alternatives, it was observed that only strategy 2 has prospects with negative NPV and had the largest spread, so it is the worse alternative for a risk-averse decision maker like DA Corp. Strategy 4 has the lowest spread, and strategy 1 and strategy 3 have similar spread, but Strategy 3 has higher possible NPV's than that of strategy 1.

The best decision is insensitive to positive values of the risk aversion coefficient, expansion, real discount rate and tax rate. However, the best decision changes from strategy 1 to strategy 3 when current capacity drops below 2.255 MM units/yr. The best decision also changes from strategy 1 to strategy 3 when the joint venture share drops below 56.65%. Regarding royalty payment, the best decision changes from strategy 1 to strategy 4 when the royalty payment that DA Corp. receives increases to 4.374%.

Information and outcome control are more valuable for the uncertainty in the initial demand when DA Corp markets than that of the unit revenue. If DA Corp is able to get information in advance, the maximum DA Corp should pay for any gathering activity is \$1.65 M and \$0.11 M for the uncertainty in initial demand when DA Corp markets and uncertainty in unit revenue respectively. If DA Corp is able to have some control on the values of the uncertainties, then the maximum DA Corp should pay is \$9.74 M and \$6.85 M for the uncertainty in initial demand when DA Corp markets and uncertainty in unit revenue respectively. Furthermore, when the initial demand when DA Corp markets is high, then switching to strategy 2 is the best option. Regarding the unit revenue uncertainty, when it is low, then switching to strategy 4 is the best option. However, since the best decision almost does not change regardless of the degree of the distinction of unit revenue uncertainty, it would be almost an immaterial distinction. This means it would not be unreasonable to consider unit revenue distinction deterministic.

Based on the decision analysis conducted and insights described above, **the final recommended course of action is to not create a partnership and not expand the current capacity of the DA Corp plant.** It is also recommended doing one more iteration of the decision cycle to improve the decision quality. For example, creating downstream options in the decision and considering hybrid strategies will improve the decision quality. One potential hybrid strategy might consider different combination of strategies depending on the region in the United States. Negotiations over the royalty payment or joint venture share with EnzyTech or any other company following the results of the sensitivity analysis might be worth exploring. Furthermore, the frame should be readjusted to consider external factor or changes of the decision elements, such as if new information on modified regulations are available. Finally, more information needs to be gathered about the uncertainties that are relevant, material and economic. If possible, DA Corp should invest in gathering more information and possibly have some control of the value of the uncertainties before making a decision. All of these suggestions will help DA Corp move closer to achieve clarity of action.

1. INTRODUCTION

1.1 Background

Daylight Alchemy Corporation is a biotechnology firm specializing in development of synthetic enzymes. DA Corp. has very little experience in marketing and production of the enzymes since they started with production only recently.

DA Corp. has developed an enzyme called the Cydone enzyme, which allows Riesling grapes to be highly susceptible to the attack of botrytis mold. This process makes the grape much sweeter, since sugar remains after water evaporates. It is predicted that DA Corp. may profit enormously from selling this enzyme, since Winemakers in the United States are eager to enhance the quality of their wines. The Botrytis mold is very rare in nature and very expensive. The management would like to choose the best way to market and produce the Cyclone enzymes.

1.2 Problem Statement

Because the decision involves a large organization with multiple decision makers and mathematical tools are needed to address the uncertainty and large number of variables, the decision can be classified high in organizational complexity and high in analytical complexity. Thus, a structured decision process involving a dialogue process was followed to solve the problem.

Before conducting the decision analysis, a vision statement is important to have a clear idea of what needs to be done. The vision statement is shown below (Figure 1) and addressed three key questions that bring clarity to the framing of the decision and help establish a common frame.



Figure 1. Vision Statement

1.3 The Decision Analysis Cycle

Due to the high complexity of the problem, the decision analysis cycle shown below in Figure 2 was followed. Given the initial situation, the first phase was the formulation, followed by the evaluation using deterministic and probabilistic analysis, and concluded with the appraisal phase. In practice, the cycle is repeated until clarity of action is achieved and the decision, which is the final phase, is reached. However, the current analysis focused on a single iteration of the cycle. Figure 2 shows as well the different tools and deliverables used in each phase of the cycle.

In the formulation phase, a dialogue was established between the decision maker and project team to achieve a well- structured decision problem with appropriate frame, uncertainties and alternatives. The evaluation phase consisted of linking the decision alternatives and corresponding values.

In the deterministic component of the evaluation phase, a value model was created, the best alternative found deterministically was identified, and the most important uncertainties were determined. In the probabilistic component of the evaluation phase, the decision tree was constructed based on the assessment of the probabilities relevant to the problem, the probability distributions of the alternatives were analyzed, and the best decision alternative was determined based on the five rules of actional thought.

Finally, in the appraisal phase, a sensitivity analysis on the inputs of the model was conducted, the value of information and control was determined, and an assessment of the six elements of the decision was made.

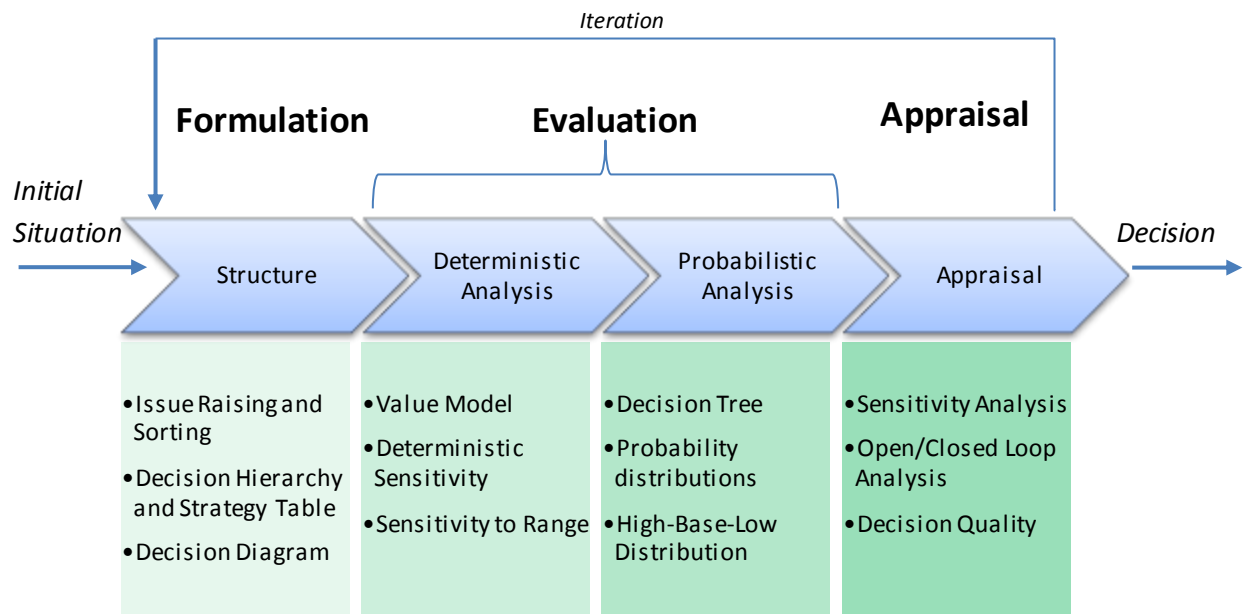


Figure 2. The Decision Analysis Cycle

2. FORMULATION

2.1 Issue Raising and Sorting

The purpose of the formulate phase is to establish a well-structured decision problem. The phase begins by taking the initial formulation of the problem and raising issues to achieve a clear fomulation that will be used as the starting point in subsequent phases of the cycle.

A brainstorming session involving the decision team and project team was conducted to raise issues. The issue raising session was done to capture decisions, uncertainties, values and other relevant issues. After the sessions, the issues were sorted in the four categories described above. The results of the issue raising and sorting are shown in Figure 3.

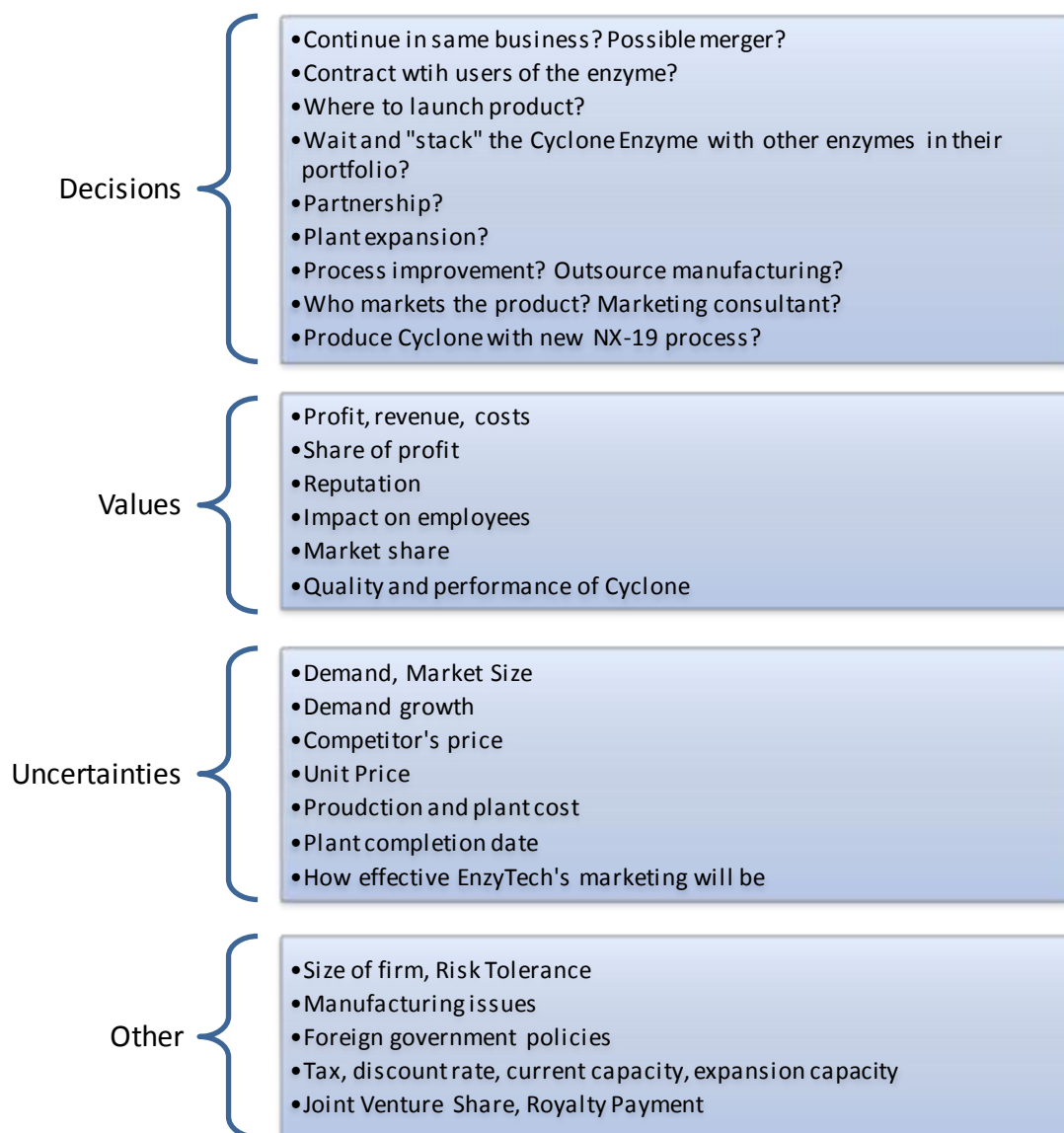


Figure 3. Issue Raising and Sorting

A force-field diagram was also constructed to help organize issues by evaluating the advantages and disadvantages. The diagram (Figure 4) shows the forces pushing for DA Corp. forming a partnership with EnzyTech and forces pushing against the partnership. From the diagram it can be seen that the forces seem to balance out, indicating that the choice of the partnership is not clear at the moment.

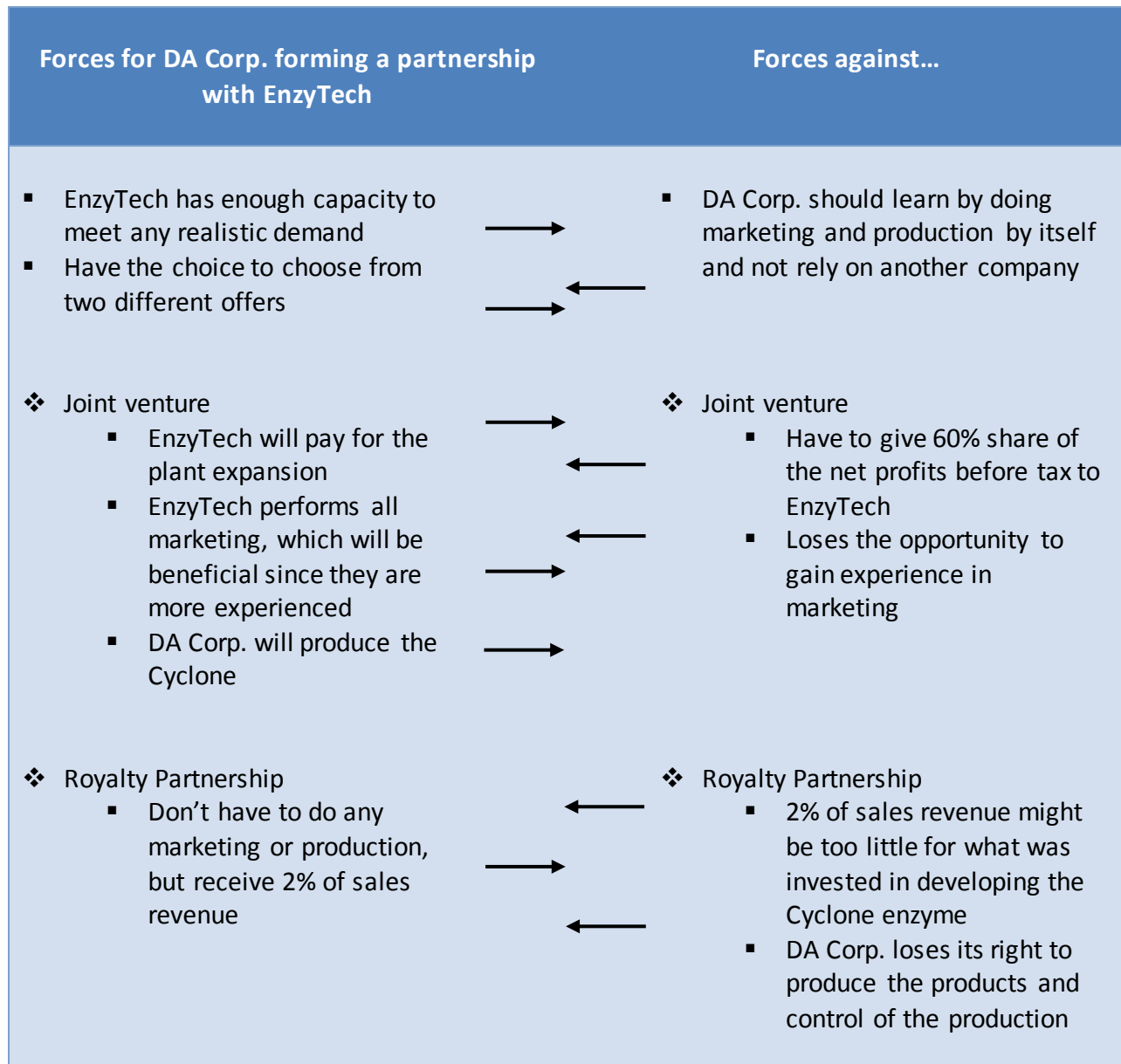


Figure 4. Force-Field Diagram

2.2 Decision Hierarchy and Strategy Table

After the sorting the issues, the decisions were classified into policy, strategic, and tactical decisions to determine the appropriate scope of the decision and what decisions to focus on in the analysis. The classification of the decisions is illustrated in the decision hierarchy shown below (Figure 5). The top of the pyramid include decisions taken as given that will not be questioned at the time of the analysis. The center of the pyramid refers to the frame that specified the set of decisions considered in the analysis. The base of the pyramid includes the decisions of how the framed decision will be implemented. For the purposes of the analysis, it was assumed that DA Corp. will produce the Cyclone with the new NX-10 process, and will not “stack” the Cyclone enzymes.

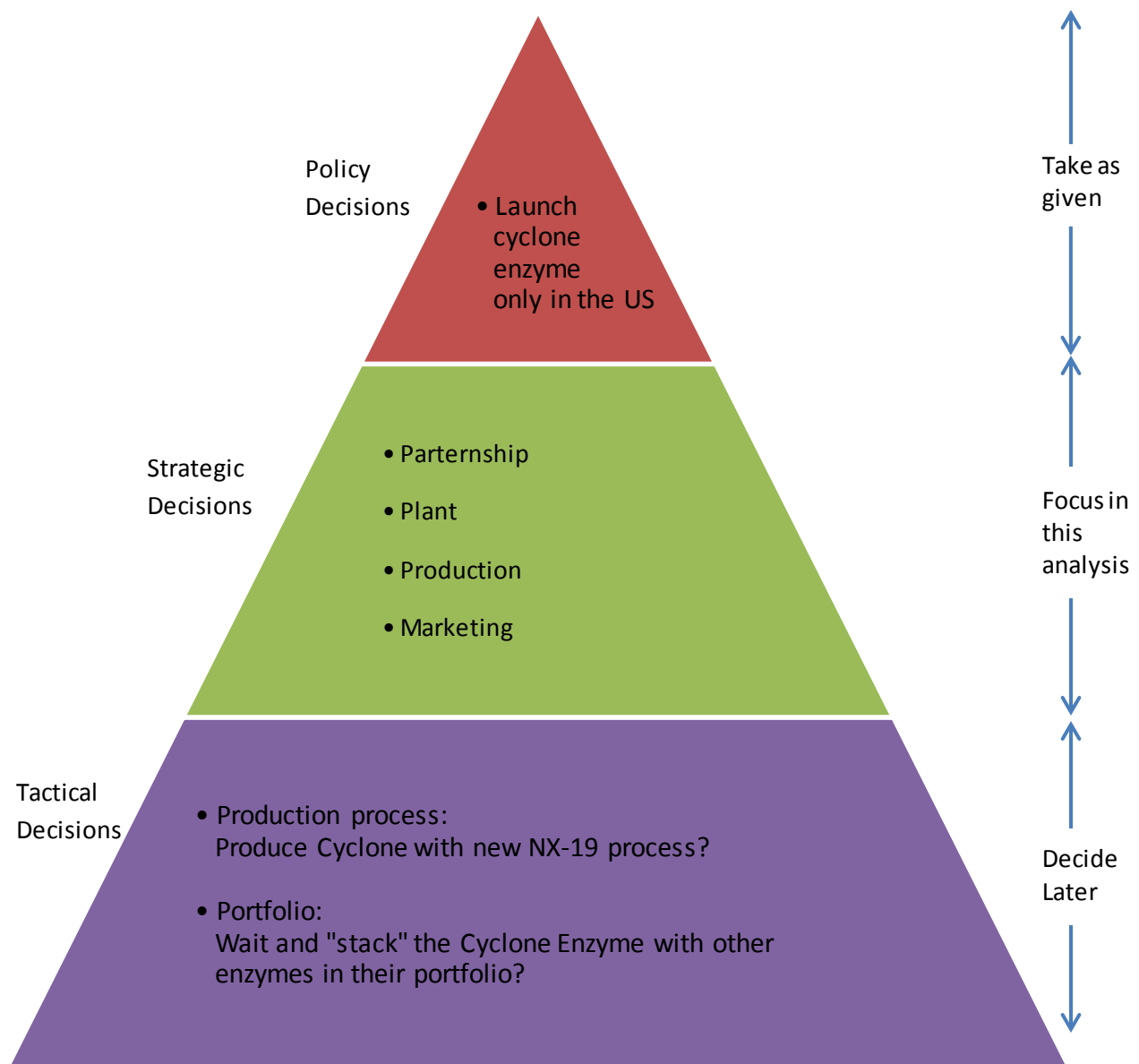


Figure 5. Decision Hierarchy

Having determined the frame of the decision, a strategy table (Table 1) was constructed using the strategic decisions of the hierarchy to identify the key strategies that will be considered in the analysis. The first column of the strategy table consists of the strategy themes identified that are a result of the different combinations of alternatives under the different strategic decisions. For example, the joint venture alternative is a combination of the choice of partnership with EnzyTech, the financing of the plant expansion by EnzyTech, the production by DA Corp., and the marketing by EnzyTech. Each of the identified strategies corresponds to an alternative in the decision tree of the evaluation phase.

Table 1. Strategy Table

Strategy	Partnership	Plant	Production	Marketing
<ul style="list-style-type: none"> 1: No Partnership/No Expansion 2: No Partnership/Expansion 3: Joint Venture 4: Royalty 	<ul style="list-style-type: none"> No partnership Partnership with EnzyTech 	<ul style="list-style-type: none"> No expansion of DA Corp. plant DA Corp. pays its plant expansion EnzyTech pays for DA Corp.'s plant expansion 	<ul style="list-style-type: none"> DA Corp. produces Cyclone enzymes EnzyTech produces Cyclone enzymes with license from DA Corp. 	<ul style="list-style-type: none"> DA Corp. markets itself EnzyTech performs all marketing

DA Corp. is facing a decision problem in production and marketing of the Cyclone enzyme. The default alternative (strategy 1) is to use current capacity and do not form a partnership. However, since current production capacity is only 2.5 million units of enzyme per year, another alternative (strategy 2) is to pay for the expansion of their production facility to 8.5 million units per year. In this case, DA Corp. will be able to market and produce the Cyclone enzyme itself. On the other hand, DA Corp. can also form a strategic alliance with a larger chemical firm, EnzyTech. DA Corp. can form either a joint venture (strategy 3) or a royalty partnership (strategy) with EnzyTech. If DA Corp. decides to form a joint venture, EnzyTech will pay for the facility expansion, in exchange with 60% share of net profits before tax. EnzyTech will market the product while DA Corp. will produce them. If DA Corp. forms a royalty partnership, EnzyTech will perform all marketing and production, and DA Corp. will receive 2% of sales revenue.

2.3 Decision Diagram

A decision diagram (Figure 6) was constructed to capture the important decisions, uncertainties and values, which are represented at the distinction level, that were characterized in the previous section. The initial demand depends on the demand if DA Corp. markets and the EnzyTech multiple, and the chosen strategy. The initial demand affects the sales, which is also a function of the uncertain demand growth and selected strategy. The strategy, sales and unit revenue uncertainty will affect the revenue. Regarding the costs, production cost and plant cost, as well as the strategy, will affect the costs. The revenue and costs create profit, which together with the strategy determine the value.

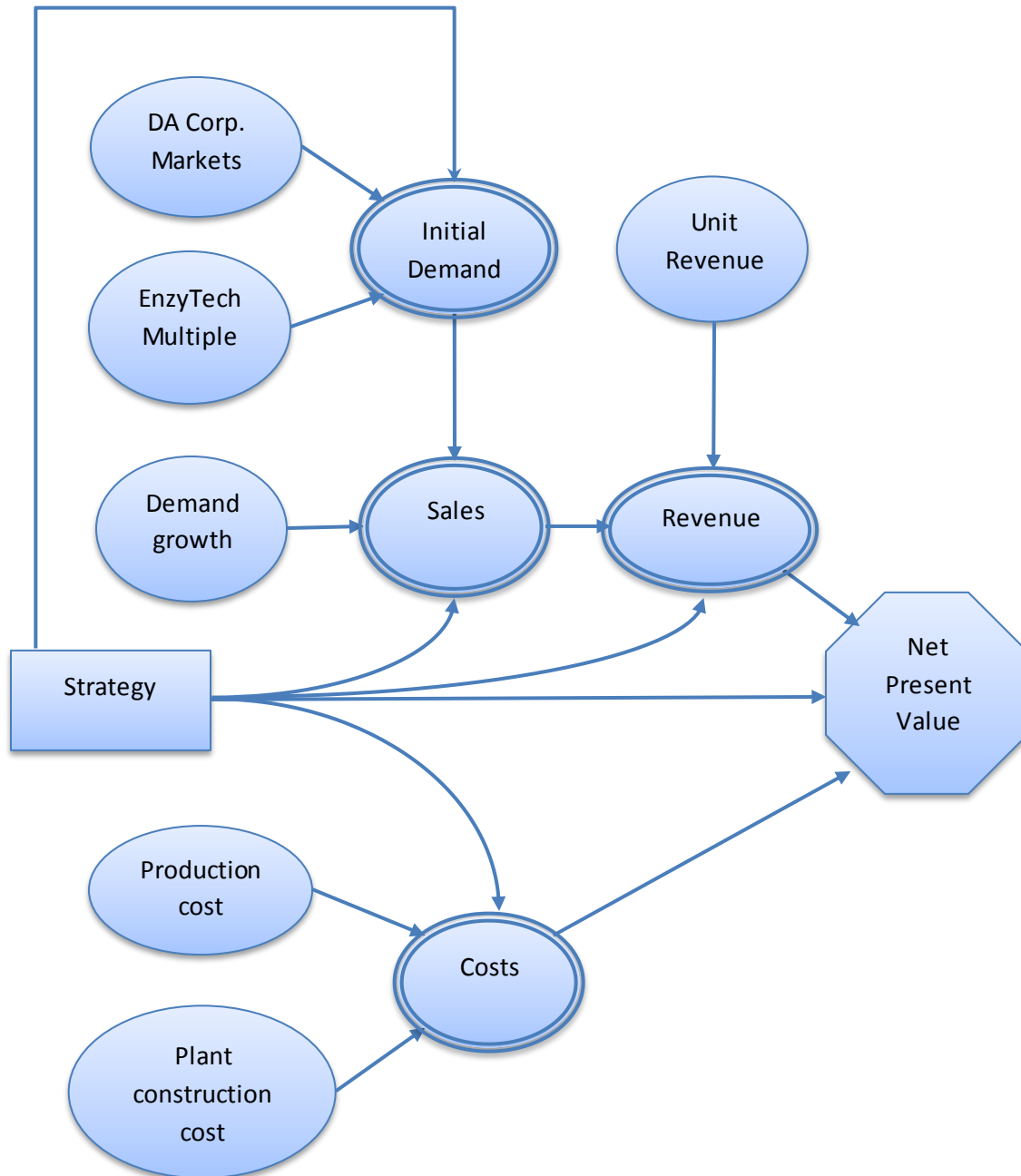


Figure 6. Decision Diagram

3. EVALUATION: Deterministic Analysis

3.1 Value Model

A value model (Appendix 8.1 and spreadsheet model enclosed) was created to capture the important features of the decision problem. In other words, the value model is a function capturing the direct values and is used as the value measure for the value node in the decision diagram. Thus, the value model provides a ranking of all the prospects for any given alternative. Table 2 and Table 3 show the parameters and initial assessment of the low-base-high points of the distribution of each uncertainty respectively that were used in the value model. One assumption is that all cash flows occur at the start of the year.

Table 2. Parameter Table

Parameter	Value	Unit
Real discount rate	8%	%
Tax Rate	38%	%
Risk Tolerance (ρ)	30	\$ million
Risk Aversion (γ)	0.033	1/ \$ million
Joint Venture Share	60%	%
Royalty Payment	2%	%
Current capacity	2.5	MM units /yr
Expansion	6	MM units /yr

Table 3. Initial Assessment of 10-50-90 points

Description	Units	Low	Base	High
Demand uncertainties				
DA Corp. markets	MM units	1.00	2.50	5.50
EnzyTech Multiple	multiple	1.30	1.60	1.80
Demand Growth Rate	%/ year	-5.00%	7.00%	9.00%
Revenue uncertainties				
Unit Revenue	\$/ unit	\$9.75	\$10.75	\$11.50
Cost uncertainties				
Production cost	\$/ unit	\$9.25	\$9.50	\$9.75
Plant construction cost	\$ million	\$13.00	\$14.50	\$17.00

3.2 Deterministic Sensitivity

The deterministic sensitivity analysis (Figure 7) compares the net present values for the four different strategies. The analysis assumes all uncertainties are at their base values of the initial assessment. According to this analysis, strategy 4 (royalty partnership), has the lowest net present value of \$5.12M, followed by strategy 2 (no partnership/ expansion) of \$8.95M. Therefore, either of these strategies would not be recommended if the problem was deterministic. On the other hand, strategy 1 (no partnership/ no expansion) has the highest net present value of \$14.04M, followed by strategy 3 (joint venture), which has a NPV \$11.90M. Thus, the analysis indicates that strategy 1 is the most profitable and best decision alternative if the problem was deterministic.

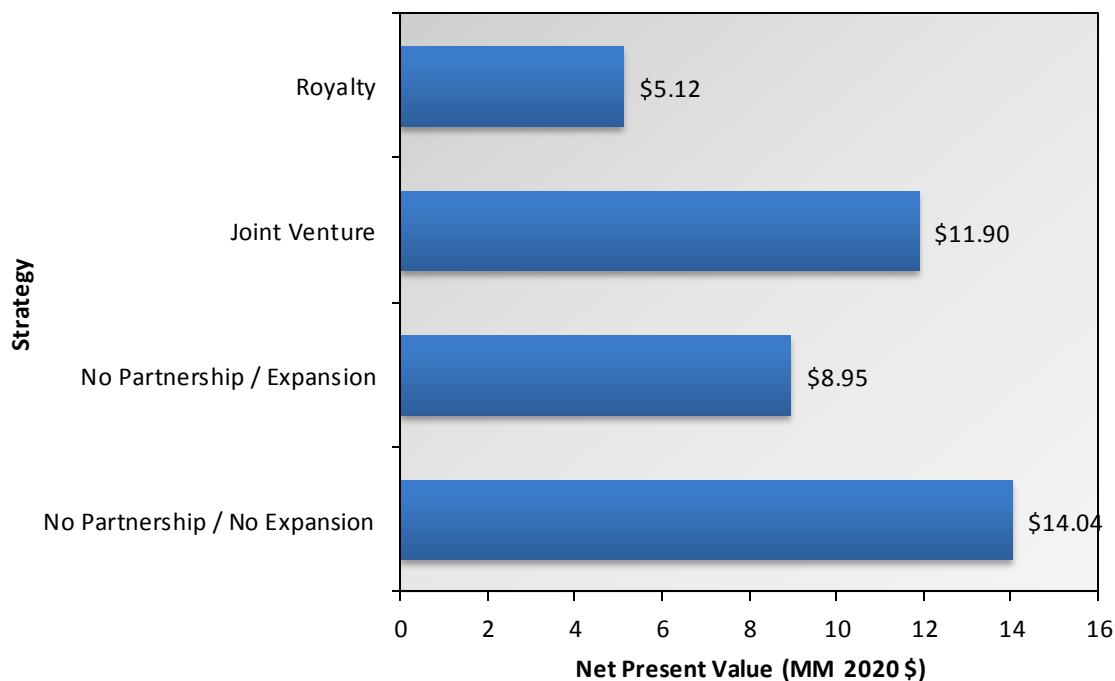


Figure 7. Deterministic Sensitivity

3.3 Sensitivity to Range

After constructing the value model, it was used to identify the direct value uncertainties that contribute the most to the variation in value. This can be represented by tornado diagrams, which show the variation in NPV in descending order for each uncertainty as it change across its 10-50-90 values with the remaining uncertainties at the their base values. The objective of the sensitivity to range analysis is to filter off some of the less significant uncertainties in the decision diagram that will make the subsequent probabilistic analysis simpler. For each strategy, it was determined that uncertainties with about at least 10% contribution and cumulative 90% contribution of the total variance will be deemed significant. It is important to note that the uncertainties were assumed to be irrelevant with each other. The results summarized in tomado diagrams are shown below. For full details on the analysis, refer to Appendix 8.2.

According to the tornado diagram for strategy 1 (Figure 8), unit revenue and demand for DA Corp. marketing had relatively high percentage of contribution to the total variance on the net present value, which were 82.67% and 9.34% respectively, for a total of 92.01 %. Although variance caused by demand for DA Corp. markets is not as high, it was still included it in the analysis for a more accurate representation. For strategy 2 (Figure 9), the percentage of variance contribution for unit revenue and demand for DA Corp. marketing were 39.66% and 53.53% respectively, for a total of 93.2%. For both strategies, the rest of the uncertainties displayed even lower percentages in variance, which means their ranges hardly affect the net present value.

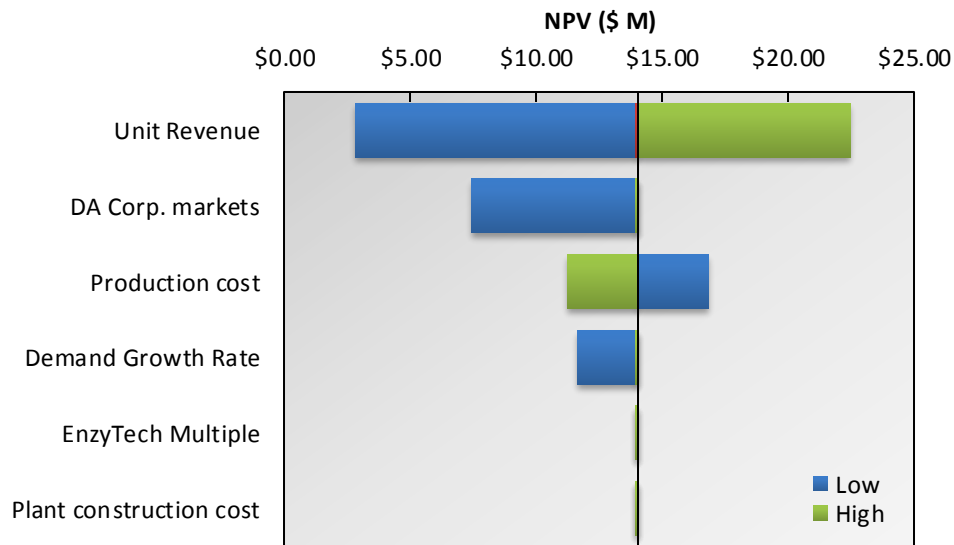


Figure 8. Tornado Diagram - Strategy 1

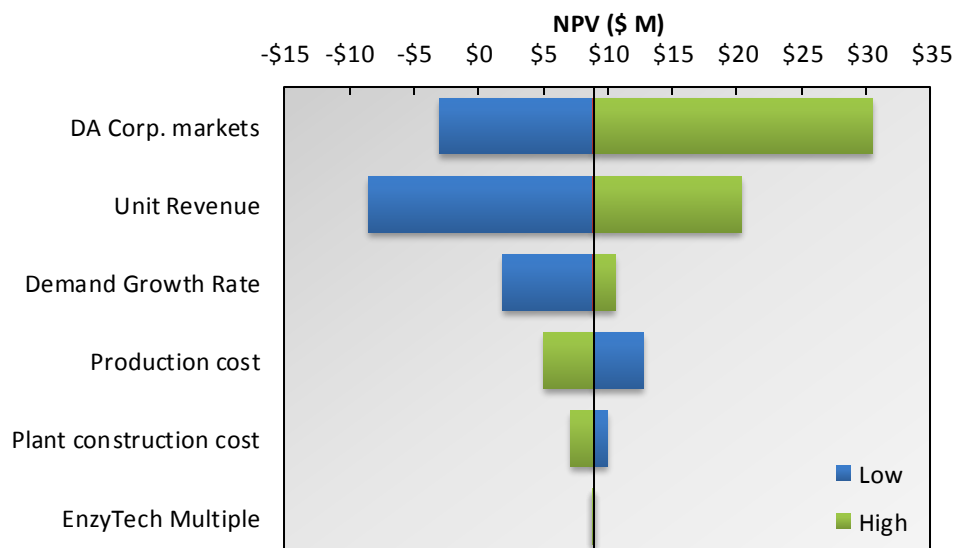


Figure 9. Tornado Diagram - Strategy 2

Interestingly, the tornado diagram of strategy 3 (Figure 10) indicated the same top two uncertainties as strategy 1 and 2. The uncertainty with most impact on the swing in net present value was the unit revenue (50.51%), followed by the demand for DA Corp. marketing (37.43). Lastly, as it is very obvious in the tornado diagram (Figure 11), the largest contributor of total variation in the net present value was by the demand for DA Corp. marketing (90.58%).

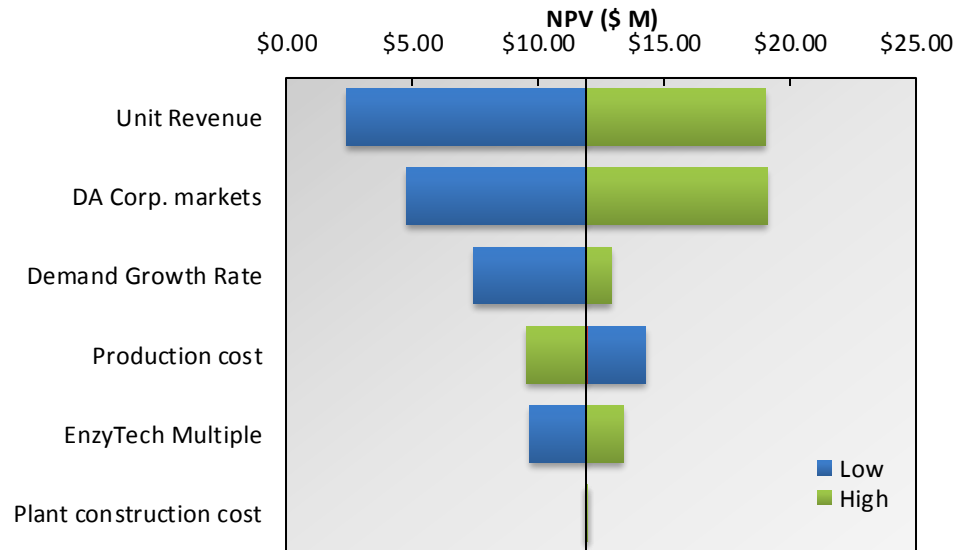


Figure 10. Tornado Diagram - Strategy 3

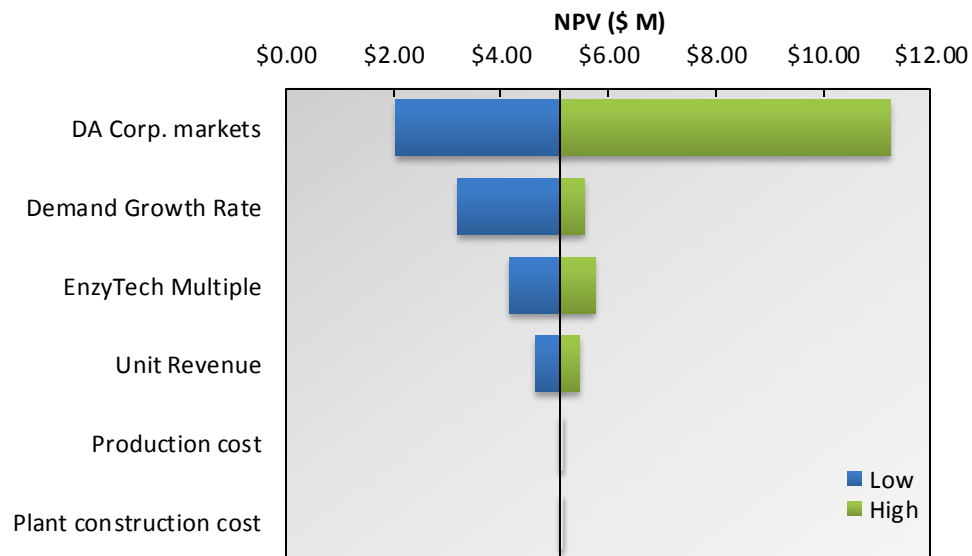


Figure 11. Tornado Diagram - Strategy 4

Therefore, the uncertainties in the demand for DA Corp. marketing for all alternatives and unit revenue for all except strategy 4 were selected for the probabilistic analysis. The rest of the uncertainties were not considered as uncertainties (set at their base values) because their ranges hardly affect the net present value.

4. EVALUATION: Probabilistic Analysis

4.1 Decision Tree

Based on the sensitivity to range analysis, an approximation was made by considering only the demand for DA Corp. marketing for all alternatives and unit revenue for all except strategy 4 as uncertainties. The rest of the uncertainties were treated as deterministic by setting them at their base values.

For a more accurate representation of the decision problem, the full cumulative distributions on all of the distinctions from DA Corp. were assessed. Based on this assessment, the low-base-high (10-50-90) points were determined (Table 4) to discretize the cumulative distributions and include the uncertainties in the decision tree. The equal area method was used to approximate the cumulative probability distributions. Thus, significant uncertainties were represented with the 10-50-90 points with .25-.5-.25 probabilities respectively. The value model used the updated 10-50-90 points for the probabilistic and appraisal phase. For more details on the updated model see Appendix 8.3.

Table 4. 10-50-90 points based on discretization of assessed full cumulative distributions

Description	Units	Low	Base	High
Demand uncertainties				
DA Corp. markets	MM units	0.95	2.75	5.45
EnzyTech Multiple	multiple	1.15	1.61	2.05
Demand Growth Rate	%/ year	-3.2%	3.6%	10.8%
Revenue uncertainties				
Unit Revenue	\$/ unit	9.95	10.70	11.38
Cost uncertainties				
Production cost	\$/ unit	9.245	9.485	9.77
Plant construction cost	\$ million	13.60	14.80	16.15

In constructing the tree, the u-values of each prospect were computed assuming a curve with exponential form ($U(x) = 1 - \exp(-\gamma \cdot x)$) because it was determined that DA Corp. follows the delta-property. In addition, it was assumed DA Corp. is risk averse because of the assessed risk tolerance. Another assumption in the analysis is that DA Corp follows the five rules of actional thought and prefers more money to less.

The resulting decision tree is shown below in Figure 12. The tree shows the four alternatives considered, the uncertainties of initial demand if DA Corp. marks and unit revenue for the corresponding alternatives, the probability assignment based on the discretization, and the probability and NPV (computed using the value model and updated 10-50-90 points) for each prospect. In addition, the u-values for each prospect and the certain equivalents for each alternative are shown.

4.2 Probability Distribution and Dominance

The second step in the probabilistic analysis was to analyze the probability distributions of each alternative and verify dominance. By looking at the prospects at the end of the tree, it can be easily checked that deterministic dominance does not exist when doing a pairwise comparison because there is no strategy that guarantees a better outcome (i.e. there is no strategy in which the highest value achieved with the strategy is less than lowest value it can be achieved with any other strategy). In other words, there is no guarantee that that DA Corp. would be better off with one strategy regardless of the outcome of the strategies. This can also be verified by comparing the cumulative probability distributions of each alternative (Figure 13).

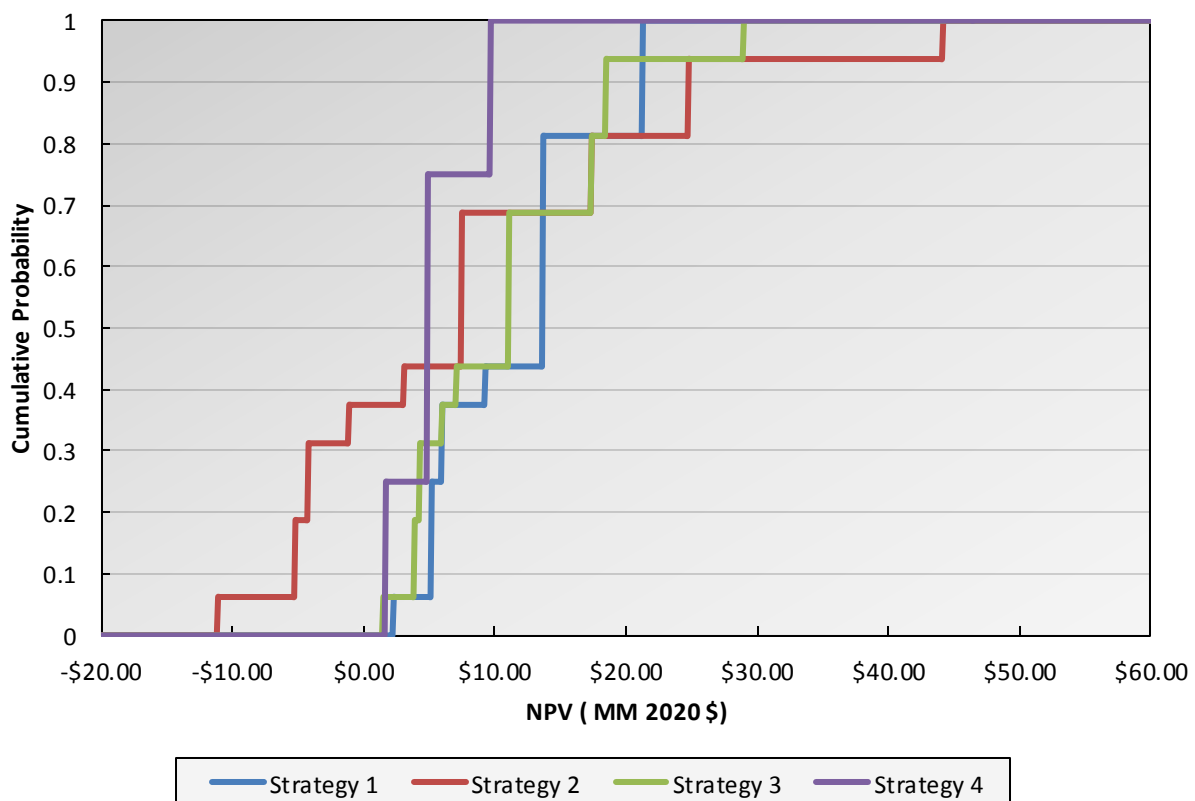


Figure 13. Cumulative Distribution Functions

First-order probabilistic dominance can be checked by looking at the cumulative distribution functions (CDF) as well. Figure 13 shows that all cumulative distributions cross each other at some point, with the exception of strategy 1 and 4. It can be seen that the CDF of strategy 1 is always below that of strategy 4 somewhere and is never above it, implying that DA Corp. will always have a higher probability of getting a better outcome with strategy 1 than with strategy 4. That is, for any given level of NPV, the probability of outcomes greater than that level of NPV is higher for strategy 1 than strategy 4. In other words, the probability of exceeding any value is at least as high with strategy 1 than with strategy 4, and is higher for at least one value. Thus, strategy 1 dominates strategy 4 with first-order probabilistic dominance. The first-order dominance results can also be verified by looking at the difference of the CDF's (Figure 14), in which a curve that does not cross zero indicates first-order probabilistic dominance.

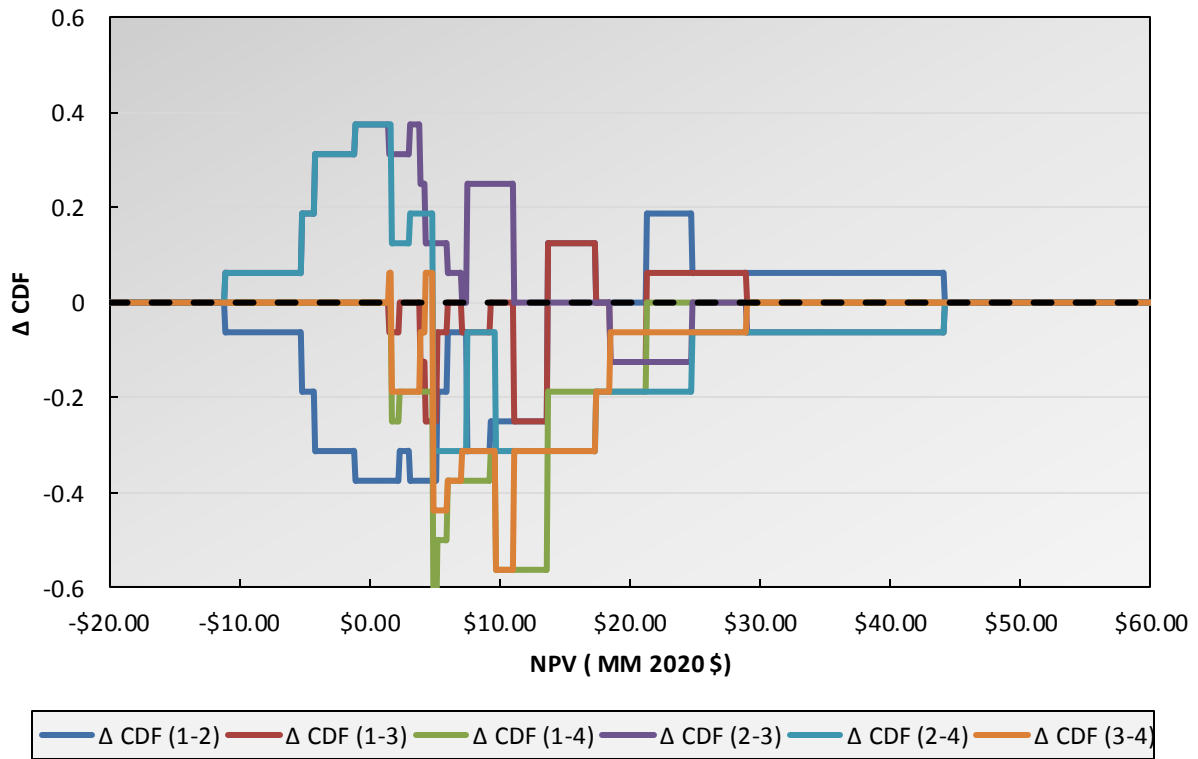


Figure 14. First-Order Probabilistic Dominance Test

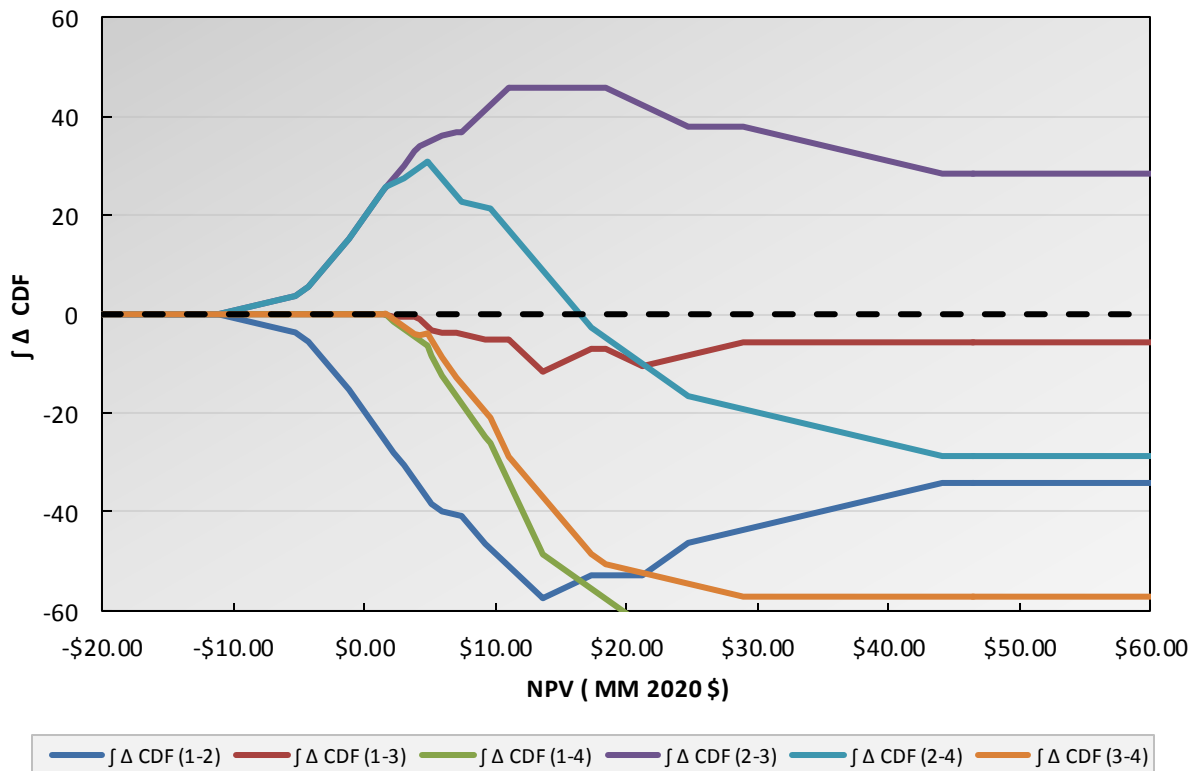


Figure 15. Second-Order Probabilistic Dominance Test

Second-order probabilistic dominance can be checked by looking at the integral of the difference of the CDF's, which is illustrated in Figure 15 above. It can be seen that all curves involving strategy 1 all remain with the same sign and do not cross zero. Thus, strategy 1 dominates all strategies with second-order probabilistic dominance. In addition, the curve involving strategy 2 and 3 exhibit the same behavior. Thus, strategy 3 dominates strategy 2 with second-order probabilistic dominance. The summary of the deterministic and probabilistic dominance results is shown in Table 5 below.

Table 5. Summary of deterministic and probabilistic dominance tests

Deterministic Dominance					
CDF (1-2)	CDF (1-3)	CDF (1-4)	CDF (2-3)	CDF (2-4)	CDF (3-4)
No	No	No	No	No	No
1s Order Probabilistic Dominance					
Δ CDF (1-2)	Δ CDF (1-3)	Δ CDF (1-4)	Δ CDF (2-3)	Δ CDF (2-4)	Δ CDF (3-4)
No	No	Yes	No	No	No
2nd Order Probabilistic Dominance					
$\int \Delta$ CDF (1-2)	$\int \Delta$ CDF (1-3)	$\int \Delta$ CDF (1-4)	$\int \Delta$ CDF (2-3)	$\int \Delta$ CDF (2-4)	$\int \Delta$ CDF (3-4)
Yes	Yes	Yes	Yes	No	No

Strategy 1 dominates strategy 4 with first-order probabilistic dominance. Thus, if the decision maker follows the five rules of actional thought and prefers more money to less ($U' > 0$), then strategy 1 is always preferred over strategy 4. Important implications are that strategy 1 guarantees a higher CE than that of strategy 4, and there is no need to assess risk preference or u-curve to determine the best alternative between strategy 1 and 4.

In addition, strategy 1 dominates all strategies with second-order probabilistic dominance. Thus, if the decision maker follows the five rules of actional thought, prefers more money to less ($U' > 0$) and is risk averse ($U'' < 0$), then strategy 1 is always preferred over all strategies. Important implications are that strategy 1 guarantees a higher CE than that of strategy 4 for a risk-averse decision maker, regardless of any other property of the decision maker's u-curve.

In addition, strategy 3 dominates strategy 2 with second-order probabilistic dominance. Thus, if the decision maker follows the five rules of actional thought, prefers more money to less ($U' > 0$) and is risk averse ($U'' < 0$), then strategy 3 is always preferred over strategy 2. Important implications are that strategy 3 guarantees a higher CE than that of strategy 2 for a risk-averse decision maker, regardless of any other property of the decision maker's u-curve.

4.3 High-Base-Low of Probability Distributions

The range and low-base-high of the probability distributions of the alternatives is shown in Table 6. A graphical illustration can be seen in Figure 16. The plot shows that only strategy 2 has prospects with negative NPV. In addition, strategy 2 has the largest spread, indicating it becomes the worse alternative for a risk-averse decision maker. Strategy 4 has the lowest certain equivalence, but smallest spread. Comparing strategy 1 and strategy 3, both have similar spread in the 10-90 points. However, strategy 3 has higher possible NPV's than that of strategy 1. Strategy 1 has the highest certainty equivalence.

Table 6. 10-50-90 points of Probability distributions of the alternatives

	Strategy 1	Strategy 2	Strategy 3	Strategy 4
Max	\$21.29	\$44.18	\$28.95	\$9.72
90%	\$21.20	\$24.70	\$18.40	\$9.60
50%	\$13.60	\$7.40	\$11.00	\$4.80
10%	\$5.10	-\$5.30	\$3.80	\$1.70
Min	\$2.29	-\$11.11	\$1.47	\$1.69

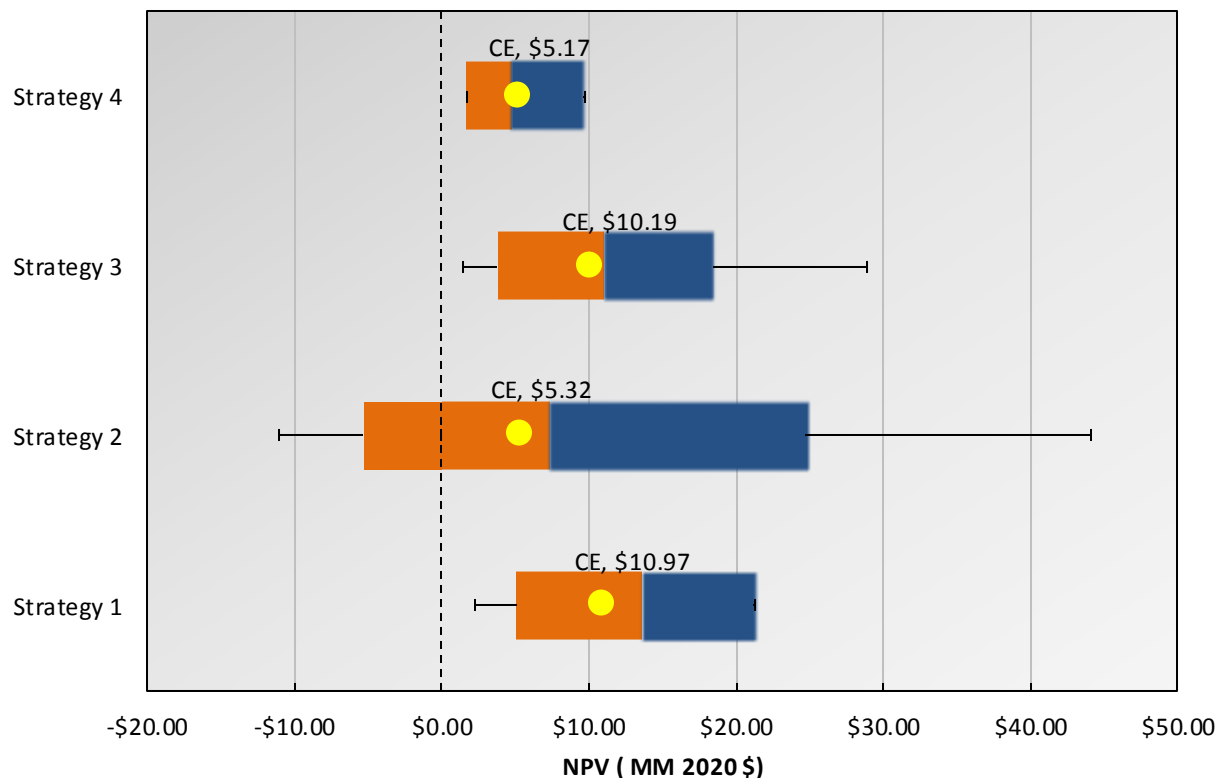


Figure 16. High-Base-Low of Strategies' Probability Distributions

5. APPRAISAL

5.1 Sensitivity Analysis

A sensitivity on the parameters of the model was conducted to determine how the best decision may change if any of the inputs change. See Appendix 8.4 for a full detail of the sensitivity analysis.

The first sensitivity analysis was done on the risk aversion coefficient (or risk tolerance coefficient). From the risk profile of all strategies (Figure 17), it can be seen that strategy 1 has the highest CE for positive values of risk aversion coefficient, indicating that strategy 1 is always preferred if the decision maker is risk averse because the decision maker is guaranteed a higher certain equivalent with strategy 1. These results agree with the second-order probabilistic dominance results of the evaluation phase. Since the best decision of the risk-averse decision maker does not change for the risk tolerance, then the precise value of the risk tolerance of the decision maker is not needed and time and effort are saved.

From the plot it can also be seen that the curves of strategy 1 and strategy 4 do not intersect, regardless of the risk aversion coefficient. This means that DA Corp. is guaranteed a higher CE with strategy 1 than with strategy 2, regardless of the risk attitude. These results also agree with the first-order probabilistic dominance results of the evaluation phase. It can also be noted that when the risk aversion coefficient falls under -0.035 (risk tolerance of -\$ 28.3 M), the best decision changes from strategy 1 to strategy 2, which makes sense since strategy 2 involves the largest uncertainty with highest possible NPVs. This is consistent with a decision maker with a more risk seeking attitude.

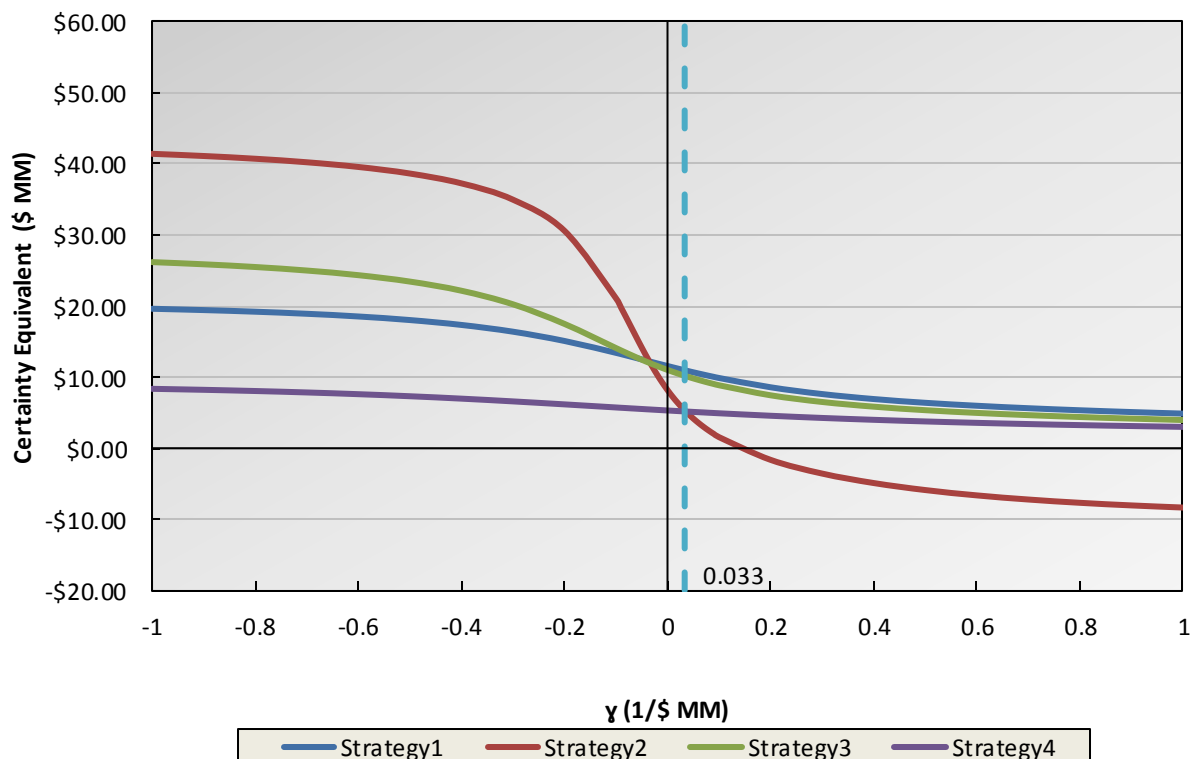


Figure 17. Sensitivity to Risk Aversion Coefficient γ

A sensitivity analysis was also done on the real discount rate (Figure 18) and tax rate (Figure 19). The results show that strategy 1 remains with the highest CE regardless of the real discount rate or tax rate in the specified range. Thus, best decision does not change with changes in these two parameters.

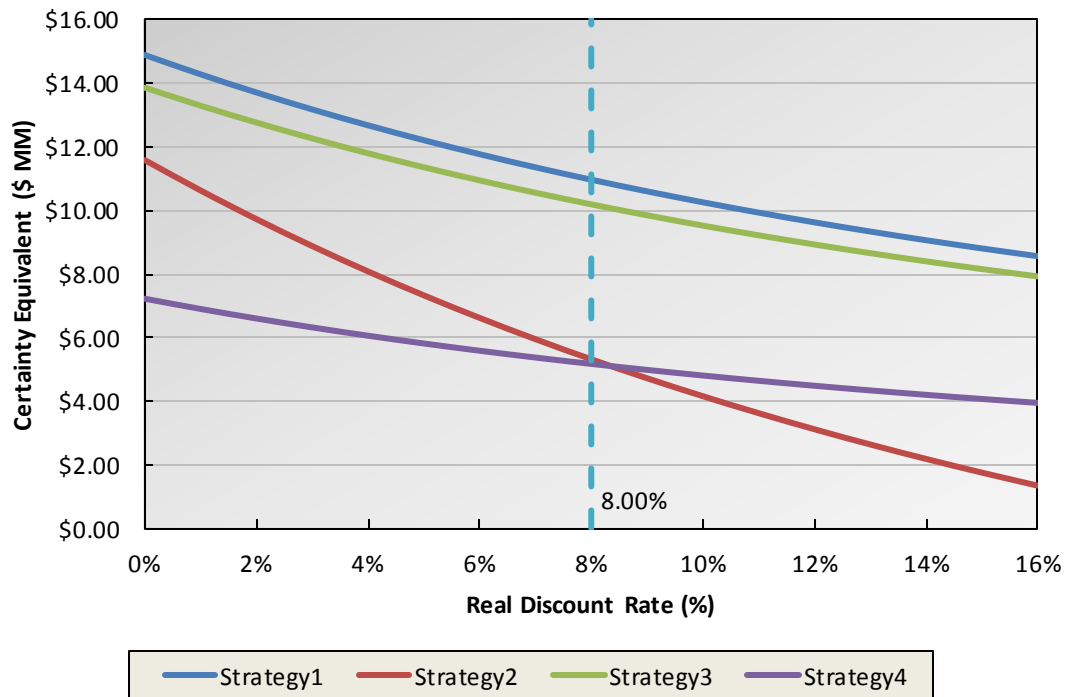


Figure 18. Sensitivity to Real Discount Rate (%)

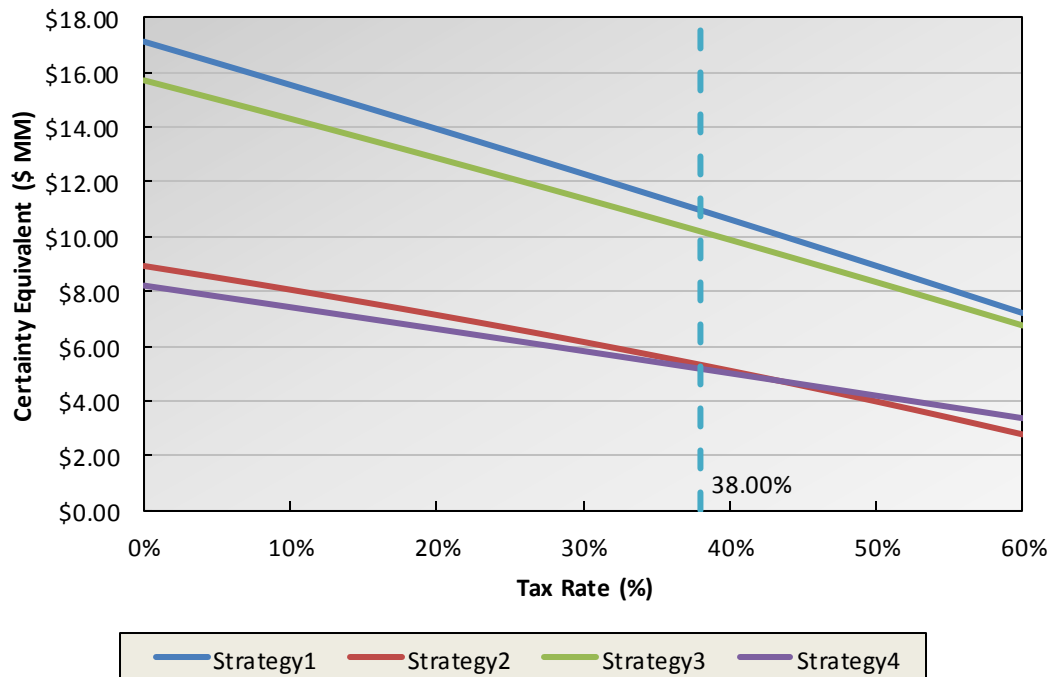


Figure 19. Sensitivity to Tax Rate (%)

Regarding the joint venture share, the sensitivity analysis (Figure 20) indicates that the best decision changes from strategy 1 to strategy 3 when the joint venture share drops below 56.65%. The sensitivity on the royalty payment that DA Corp. would receive (Figure 21) shows that the best decision changes from strategy 1 to strategy 4 when the royalty payment that DA Corp. would receive exceeds 4.374%. Both results make sense since lowering the venture share and increasing the received royalty payment would make strategy 3 and strategy 4 more attractive respectively.

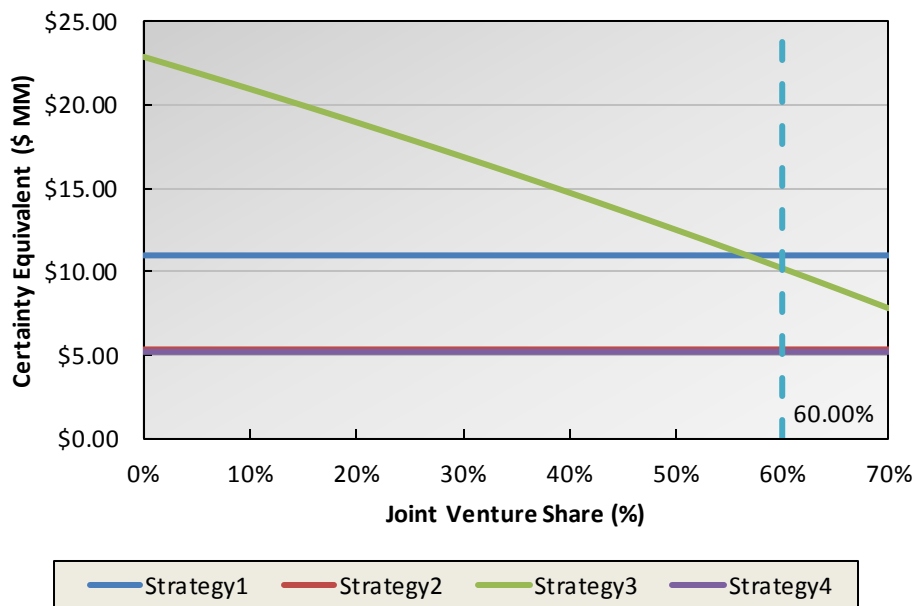


Figure 20. Sensitivity to Joint Venture Share (%)

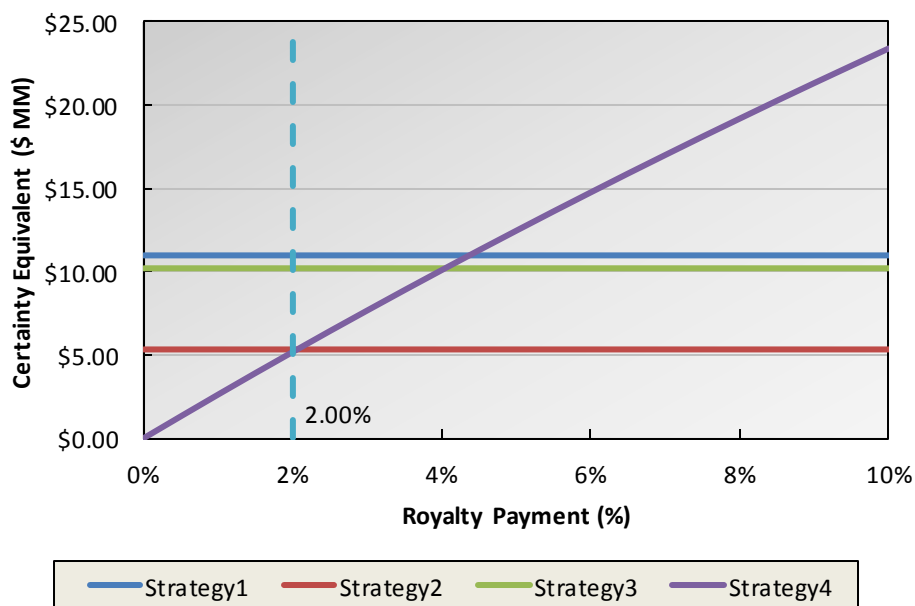


Figure 21. Sensitivity to Royalty Payment (%)

Regarding the current capacity, the sensitivity analysis (Figure 20) indicates that the best decision changes from strategy 1 to strategy 3 when current capacity drops below 2.255 MM units/yr. The sensitivity on the expansion capacity of DA Corp.'s plant (Figure 21) shows that the best decision is insensitive to the expansion capacity (MM units/yr). This last plot shows that the CE increases as the expansion capacity increases for strategy 2 and strategy 3 until the CE saturates, which makes sense since there is a point in which more capacity does not help because all the demand is already met.

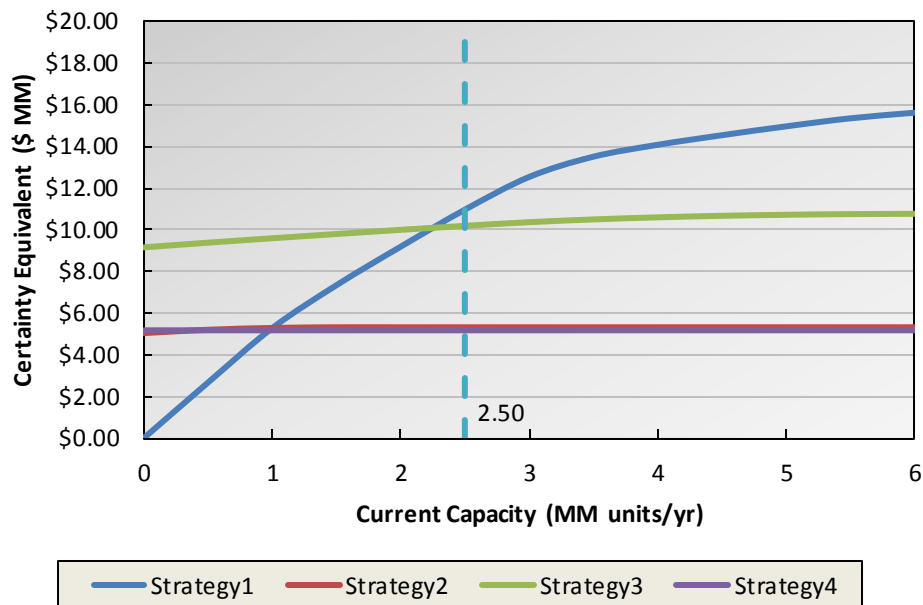


Figure 22. Sensitivity to Current Capacity (MM units/yr)

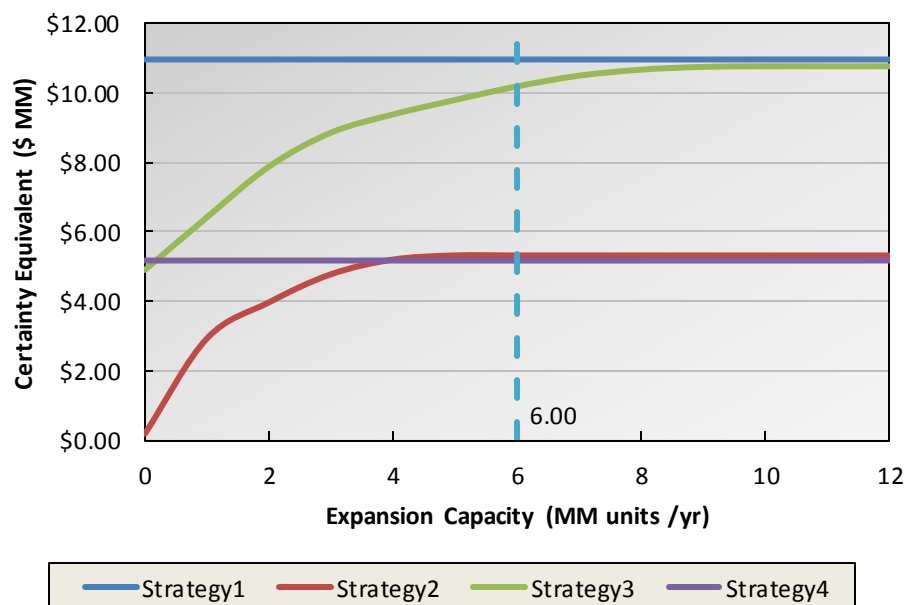


Figure 23. Sensitivity to Expansion Capacity (MM units /yr)

A summary of the sensitivity analysis is shown below in (Table 7).

Table 7. Sensitivity Analysis Summary

Parameter (Y)	Original (R)	Indifference point (Z)	% difference	Best Strategy If		
				Y = R	Y < Z	Y > Z
Risk Tolerance (ρ) (\$ M)	30	-28.3	-194.3%	1	2	1
Real discount rate (%)	38%	None	NA	1	1	1
Tax Rate (%)	8%	None	NA	1	1	1
Joint Venture Share (%)	60%	56.65%	-5.58%	1	3	1
Royalty Payment (%)	2%	4.37%	+118.7%	1	1	4
Current capacity (MM units /yr)	2.5	2.255	-9.80%	1	3	1
Expansion (MM units /yr)	6	None	NA	1	1	1

5.2 Open/Closed Loop Analysis

The value of perfect information or each uncertainty considered in the probabilistic analysis was calculated by taking the difference of the CE with perfect information (i.e. the decision tree with the uncertainty distinction before making the decision) and the current CE. Similarly, the value of perfect control was calculated by taking the difference of the CE with perfect control (i.e. solving the decision tree and setting the probabilities of uncertainties of the different levels to 1 or 0) and the current CE. Note that this computation can be done under the assumption that DA Corp. follows the delta property. More details on the analysis can be found in Appendix 8.5.

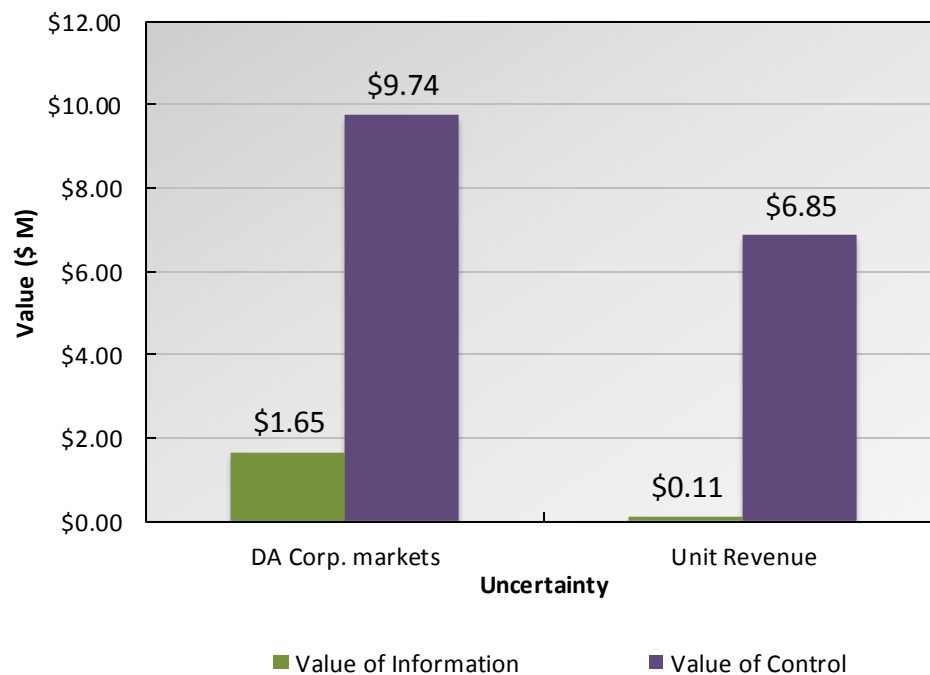


Figure 24. Value of Information and Control

The results of the analysis are summarized above in Figure 24. As expected, the value of control is higher than the value of information for both uncertainties. In addition, the corresponding value of information and control are both higher in the uncertainty of initial demand when DA Corp. markets compared to that of the unit revenue. If DA Corp is able to get information in advance, the value of perfect information is the maximum DA Corp should pay. Regarding the value of control, the corresponding amounts displayed in plot are the maximum amounts that DA Corp should pay if they can control the value of the uncertainties. Furthermore, since the value of information and control is higher for the uncertainty in the initial demand when DA Corp markets, this uncertainty is more valuable than that of the unit revenue.

An open and closed loop sensitivity was done in order to study the relevance effect of the uncertainties. The results of this analysis provided insights on the sensitivity of the best decision to the available information about the outcomes of an uncertainty. For an open loop sensitivity, the outcomes of the uncertainties were changed by setting the probabilities of uncertainties of the different levels to 1 or 0 while keeping an alternative decision fixed (e.g. in this case strategy 1). The idea was to study how the value of the chosen alternative (e.g. CE) changed as the outcome changes. For a closed loop sensitivity, the same analysis was done but the best decision was chosen each time for the different outcomes of the uncertainty and the value (e.g. CE) of this decision was studied. The results for the uncertainties are shown in Figure 25 and Figure 26.

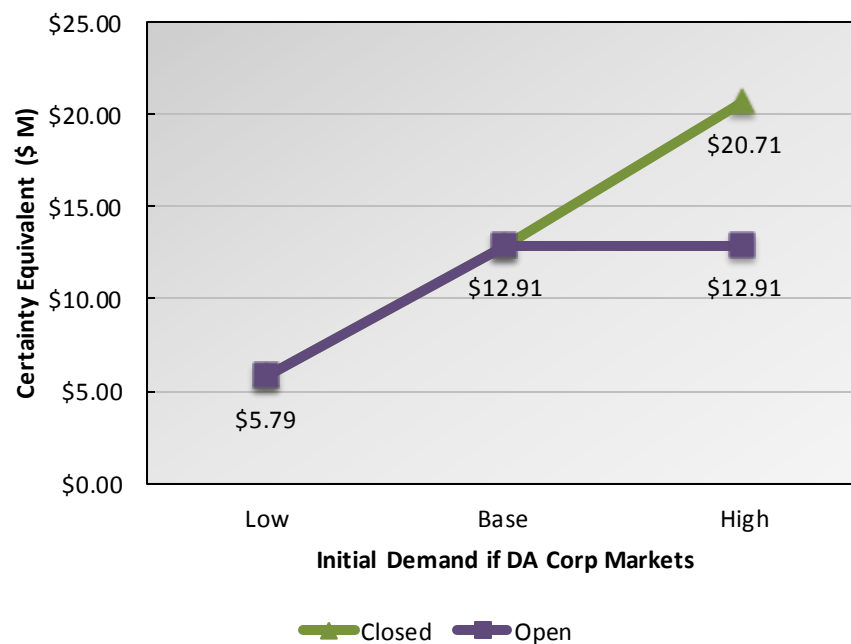


Figure 25. Open & Closed Loop Sensitivity Analysis for Initial Demand if DA Corp Markets

As expected, the values for the closed loop are at least as high as the ones of the open loop. From Figure 25, it can be seen that when the initial demand when DA Corp. markets is high, then switching to strategy 2 is the best option. This makes sense since if the demand is high, a higher capacity is more profitable to meet the demand.

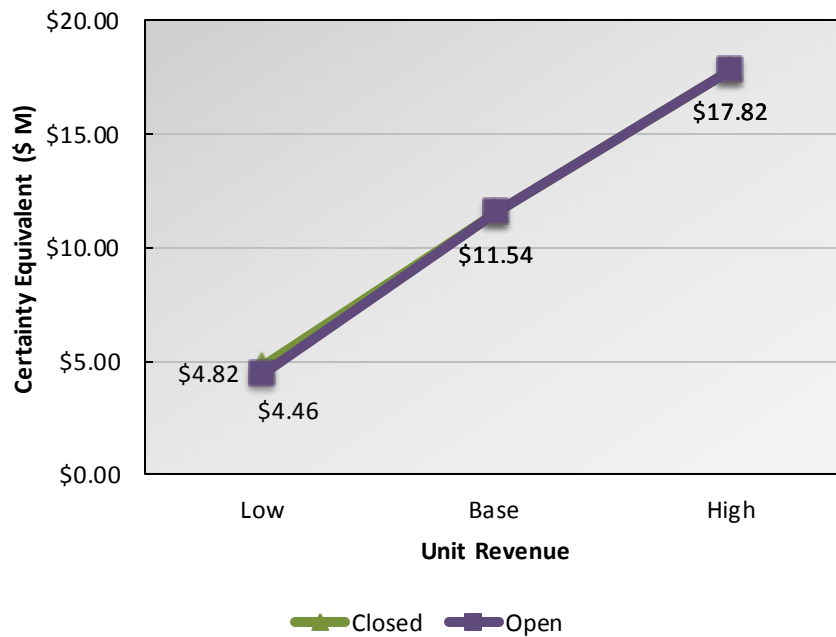


Figure 26. Open & Closed Loop Sensitivity Analysis for Unit Revenue

From Figure 26 , it can be seen that when the unit revenue is low, then switching to strategy 4 is the best option. However, the difference in CE between the current optimal decision (e.g. strategy 1) and the one when unit revenue is low (e.g. strategy 4) is minimal. Because the open and closed loop curves for unit revenue are almost overlapping, meaning that the best decision almost does not change for the different outcomes of the uncertainties, the resulting value of information is close to zero, which agrees with the results from Figure 24. The difference between the closed loop and open loop represents the effect of receiving information. Thus, in this case the uncertainty in the unit revenue would be almost an immaterial distinction since the best decision almost does not change regardless of the degree of the distinction. Because the swing is almost zero, it would not be unreasonable to consider this distinction deterministic.

5.3 Decision Quality

The last step of the appraisal was to measure the decision quality and the closeness to clarity of action. The six elements of a decision were rated on a scale of 0% to 100%, in which 100% meant that beyond this point the improvement is not worth the effort. The decision quality is shown in Figure 27.

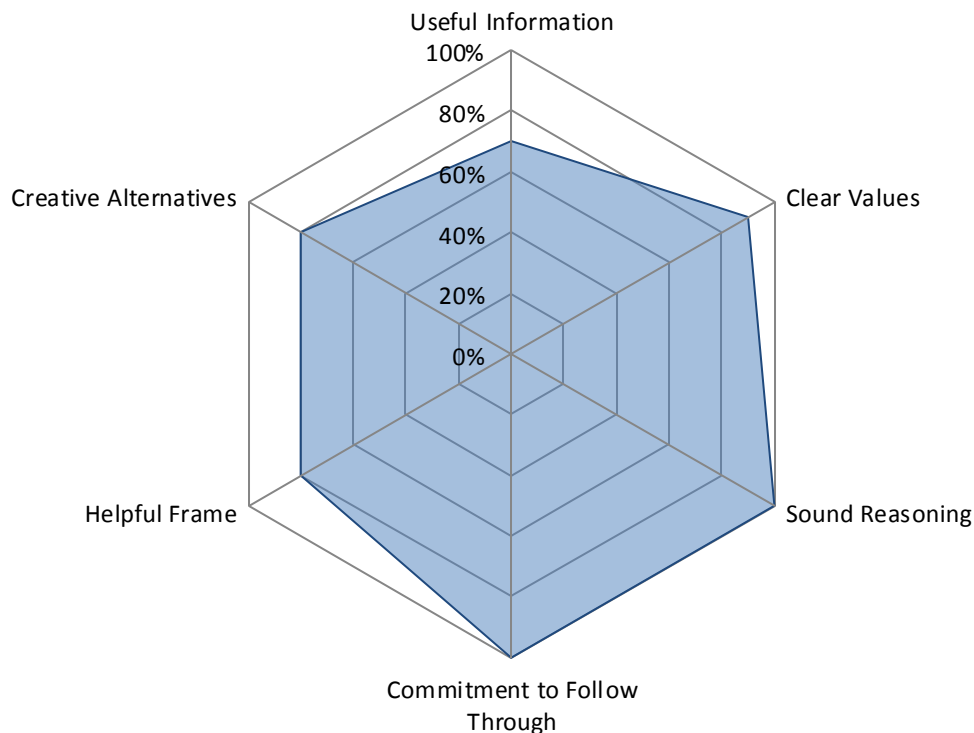


Figure 27. Decision Quality

The elements of clear values, sound reasoning and commitment to follow through were rated high because the value function seemed to capture the true values, DA Corp was comfortable with the five-rules of actional thought and accepting the recommendation. The element of creative alternatives was rated slightly lower because there is a need to create more alternatives that are more different and would help DA Corp, such as consideration of hybrid alternatives or options for alternatives. Similarly, the helpful frame was also rated slightly lower because more issues, uncertainties, alternatives and values should be considered to frame the problem. The element of useful information was rated lower because more information needs to be gathered about the uncertainties that are relevant, material and economic. For example, one suggestion would be to determine possible relevance between uncertainties. Based on the decision quality, a second iteration of the decision analysis cycle would be recommended to improve the elements of the decision described above.

6. CONCLUSIONS

6.1 Summary

The decision situation of Daylight Alchemy Corporation in marketing and producing the Cyclone enzymes was analyzed using a structured approach. The case was taken through one iteration of the decision analysis cycle, which is defined as formulation, evaluation, appraisal, and decision. Various decision tools, such as issue raising, spreadsheet model, decision tree, and sensitivity analysis, were used to conduct the analyses. Four decision alternatives were analyzed: no partnership/no expansion (strategy 1), no partnership/expansion (strategy 2), joint venture with EnzyTech (strategy 3), and royalty partnership with EnzyTech (strategy 4). In addition, NPV was considered as the value measure of the different prospects. Many insights were generated and are summarized below.

6.2 Highlights

The following discussion of the main insights is based on the assumption that DA Corp follows the five rules of actional thought and prefers more money to less. In addition, the discussion assumes DA Corp is risk averse and follows the delta property as these were corroborated in the assessment of DA Corp. Cash flows were assumed to occur at the start of the year in the value model, and uncertainties were assumed to be irrelevant with each other.

Strategy 1 is the most profitable and best decision alternative if the problem did not involve uncertainties. The demand if DA Corp. markets for all alternatives and unit revenue for all except strategy 4 were considered to be significant uncertainties. Strategy 1 was also found to be the best decision if uncertainty and risk is considered. Furthermore, the ranking of the alternatives was the same regardless of whether the uncertainties are considered or not.

There is no guarantee that that DA Corp. would be better off with one strategy regardless of the outcome of the strategies (i.e. no deterministic dominance). However, DA Corp always prefers strategy 1 over the other strategies, and always prefers strategy 3 over strategy 2 (i.e. second-order probabilistic dominance). Regarding the prospects and distribution of the decision alternatives, it was observed that only strategy 2 has prospects with negative NPV and had the largest spread, so it is the worse alternative for a risk-averse decision maker like DA Corp. Strategy 4 has the lowest spread, and strategy 1 and strategy 3 have similar spread, but Strategy 3 has higher possible NPV's than that of strategy 1.

The best decision is insensitive to positive values of the risk aversion coefficient, expansion, real discount rate and tax rate. However, the best decision changes from strategy 1 to strategy 3 when current capacity drops below 2.255 MM units/yr. The best decision also changes from strategy 1 to strategy 3 when the joint venture share drops below 56.65%. Regarding royalty payment, the best decision changes from strategy 1 to strategy 4 when the royalty payment that DA Corp. receives increases to 4.374%.

Information and outcome control are more valuable for the uncertainty in the initial demand when DA Corp markets than that of the unit revenue. If DA Corp is able to get information in advance, the maximum DA Corp should pay for any gathering activity is \$1.65 M and \$0.11 M for the uncertainty in initial demand when DA Corp markets and uncertainty in unit revenue respectively. If DA Corp is able to

have some control on the values of the uncertainties, then the maximum DA Corp should pay is \$9.74 M and \$6.85 M for the uncertainty in initial demand when DA Corp markets and uncertainty in unit revenue respectively. Furthermore, when the initial demand when DA Corp markets is high, then switching to strategy 2 is the best option. Regarding the unit revenue uncertainty, when it is low, then switching to strategy 4 is the best option. However, since the best decision almost does not change regardless of the degree of the distinction of unit revenue uncertainty, it would be almost an immaterial distinction. Because the swing is almost zero, it would not be unreasonable to consider unit revenue distinction deterministic.

6.3 Recommendation

Based on the decision analysis conducted and insights described above, the final recommended course of action is to not create a partnership and not expand the current capacity of the DA Corp plant. It is also recommended doing one more iteration of the decision cycle to improve the decision quality. For example, creating downstream options in the decision and considering hybrid strategies will improve the decision quality. One potential hybrid strategy might consider different combination of strategies depending on the region in the United States. Negotiations over the royalty payment or joint venture share with EnzyTech or any other company following the results of the sensitivity analysis might be worth exploring. Furthermore, the frame should be readjusted to consider external factor or changes of the decision elements, such as if new information on modified regulations are available. Finally, more information needs to be gathered about the uncertainties that are relevant, material and economic. For example, one suggestion would be to determine possible relevance between uncertainties. If possible, DA Corp should invest in gathering more information and possibly have some control of the value of the uncertainties before making a decision. All of these suggestions will help DA Corp move closer to achieve clarity of action.

7. REFERENCES

Abbas, Ali. *Class Lectures and Manuscript*. University of Illinois, Urbana, IL. Fall 2012.

8. APPENDIX

8.1 Value Model

Daylight Alchemy Corporation's Value Model

Section 1 - Strategy Selection

Strategy	4	strategy
Strategy Name	Royalty	strategy_name
Strategy Descriptions		
1	No Partnership/ No Expansion	
2	No Partnership/ Expansion	
3	Joint Venture	
4	Royalty	

Section 2 - Constants

Description	Units	Value	Name
Real discount rate	%	8%	discount_rate
Tax Rate	%	38%	tax_rate
Risk Tolerance	\$ million	30	risk_tol
Joint Venture Share	%	60.0%	JV_share
Royalty Payment	%	2.0%	Royalty
Current capacity	MM units /yr	2.5	Capacity
Expansion	MM units/yr	6	Expansion

Section 3 - Uncertainties

Description	Units	Index	In Use	Name	Low	Base	High
Demand uncertainties							
DA Corp. markets	MM units	2	2.5	dem_DAC	1.0	2.5	5.5
EnzyTech Multiple	multiple	2	1.6	dem_ET	1.3	1.6	1.8
Demand Growth Rate	%/ year	2	7%	grow th_rate	-5%	7%	9%
Revenue uncertainties							
Unit Revenue	\$/ unit	2	10.75	unit_revenue	9.75	10.75	11.50
Cost uncertainties							
Production cost	\$/ unit	2	9.5	prod_cost	9.25	9.5	9.75
Plant construction cost	\$ million	2	14.5	const_cost	13	14.5	17

Section 4 - Calculations												
No Partnership / No Expansion												
Year Period			2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
			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
Production Cost			MM \$	23.75	23.75	23.75	23.75	23.75	23.75	23.75	23.75	23.75
Plant Cost			MM \$	0.00								
JV Payment			MM \$	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
Earnings Before Tax			MM \$	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
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
Tax Payment			MM \$	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
Present Equivalent			MM 2020 \$	1.94	1.79	1.66	1.54	1.42	1.32	1.22	1.13	1.05
Net Present Value (NPV)			MM 2020 \$	14.04								

Section 4 - Calculations												
No Partnership / 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	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	
Sales	MM units	2.50	2.68	2.86	3.06	3.28	3.51	3.75	4.01	4.30	4.60	
Revenue	MM \$	26.88	28.76	30.77	32.92	35.23	37.69	40.33	43.16	46.18	49.41	
Production Cost	MM \$	23.75	25.41	27.19	29.09	31.13	33.31	35.64	38.14	40.81	43.66	
Plant Cost	MM \$	14.50										
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 \$	-11.38	3.34	3.58	3.83	4.10	4.38	4.69	5.02	5.37	5.75	
Taxes	MM \$	-4.32	1.27	1.36	1.45	1.56	1.67	1.78	1.91	2.04	2.18	
Tax Credit Available for Next Year	MM \$	4.32	3.05	1.69	0.24	0.00	0.00	0.00	0.00	0.00	0.00	
Tax Payment	MM \$	0.00	0.00	0.00	0.00	1.32	1.67	1.78	1.91	2.04	2.18	
Cash Flow	MM\$	-11.38	3.34	3.58	3.83	2.78	2.72	2.91	3.11	3.33	3.56	
Present Equivalent	MM 2020 \$	-11.38	3.10	3.07	3.04	2.04	1.85	1.83	1.82	1.80	1.78	
Net Present Value (NPV)	MM 2020 \$	8.95										

Section 4 - Calculations												
Joint Venture												
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	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50
	Sales	MM units	4.00	4.28	4.58	4.90	5.24	5.61	6.00	6.42	6.87	7.35
Revenue												
	MM \$	43.00	46.01	49.23	52.68	56.36	60.31	64.53	69.05	73.88	79.05	
Production Cost												
	MM \$	38.00	40.66	43.51	46.55	49.81	53.30	57.03	61.02	65.29	69.86	
Plant Cost												
	MM \$	0.00										
JV Payment												
	MM \$	3.00	3.21	3.43	3.68	3.93	4.21	4.50	4.82	5.15	5.52	
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 \$	2.00	2.14	2.29	2.45	2.62	2.81	3.00	3.21	3.44	3.68	
Taxes												
	MM \$	0.76	0.81	0.87	0.93	1.00	1.07	1.14	1.22	1.31	1.40	
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 \$	0.76	0.81	0.87	0.93	1.00	1.07	1.14	1.22	1.31	1.40	
Cash Flow												
	MM\$	1.24	1.33	1.42	1.52	1.63	1.74	1.86	1.99	2.13	2.28	
Present Equivalent												
	MM 2020 \$	1.24	1.23	1.22	1.21	1.19	1.18	1.17	1.16	1.15	1.14	
Net Present Value (NPV)												
	MM 2020 \$	11.90										

Section 4 - Calculations												
Royalty												
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	4.00	4.28	4.58	4.90	5.24	5.61	6.00	6.42	6.87	7.35
	Sales	MM units	4.00	4.28	4.58	4.90	5.24	5.61	6.00	6.42	6.87	7.35
Revenue												
	MM \$	43.00	46.01	49.23	52.68	56.36	60.31	64.53	69.05	73.88	79.05	
Production Cost												
	MM \$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Plant Cost												
	MM \$	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	0.00
Royalty Payment												
	MM \$	42.14	45.09	48.25	51.62	55.24	59.10	63.24	67.67	72.40	77.47	
Earnings Before Tax												
	MM \$	0.86	0.92	0.98	1.05	1.13	1.21	1.29	1.38	1.48	1.58	
Taxes												
	MM \$	0.33	0.35	0.37	0.40	0.43	0.46	0.49	0.52	0.56	0.60	
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	0.00
Tax Payment												
	MM \$	0.33	0.35	0.37	0.40	0.43	0.46	0.49	0.52	0.56	0.60	
Cash Flow												
	MM\$	0.53	0.57	0.61	0.65	0.70	0.75	0.80	0.86	0.92	0.98	
Present Equivalent												
	MM 2020 \$	0.53	0.53	0.52	0.52	0.51	0.51	0.50	0.50	0.49	0.49	
Net Present Value (NPV)												
	MM 2020 \$	5.12										

Data Tables

One-way Data Table for strategy

	Strategy	\$5.12
No Partnership/No Expansion	1	14.04
No Partnership/Expansion	2	8.95
Joint Venture	3	11.90
Royalty	4	5.12

Two-way Data Table for strategy and uncertainty level

DA Corp. markets				
\$5.12	1	2	3	
1	\$7.43	\$14.04	\$14.04	
2	-\$3.04	\$8.95	\$30.51	
3	\$4.76	11.90	\$19.10	
4	\$2.05	\$5.12	\$11.25	

EnzyTech Multiple				
\$5.12	1	2	3	
1	\$14.04	\$14.04	\$14.04	
2	\$8.95	\$8.95	\$8.95	
3	\$9.67	\$11.90	\$13.38	
4	\$4.16	\$5.12	\$5.75	

Demand Growth Rate				
\$5.12	1	2	3	
1	\$11.63	\$14.04	\$14.04	
2	\$1.90	\$8.95	\$10.58	
3	\$7.44	\$11.90	\$12.90	
4	\$3.20	\$5.12	\$5.56	

Unit Revenue				
\$5.12	1	2	3	
1	\$2.81	\$14.04	\$22.47	
2	-\$8.50	\$8.95	\$20.37	
3	\$2.38	\$11.90	\$19.03	
4	\$4.64	\$5.12	\$5.47	

Production cost				
\$5.12	1	2	3	
1	\$16.85	\$14.04	\$11.23	
2	\$12.78	\$8.95	\$5.06	
3	\$14.28	\$11.90	\$9.52	
4	\$5.12	\$5.12	\$5.12	

Plant construction cost				
\$5.12	1	2	3	
1	\$14.04	\$14.04	\$14.04	
2	\$10.01	\$8.95	\$7.14	
3	\$11.90	\$11.90	\$11.90	
4	\$5.12	\$5.12	\$5.12	

8.2 Sensitivity to Range

Strategy 1		NPV					
	Low	Base	High	D	D ²	% Var	% Cum
Unit Revenue	\$2.81	\$14.04	\$22.47	\$19.66	386	82.67%	82.67%
DA Corp. markets	\$7.43	\$14.04	\$14.04	\$6.61	44	9.34%	92.01%
Production cost	\$16.85	\$14.04	\$11.23	\$5.62	32	6.75%	98.76%
Demand Growth Rate	\$11.63	\$14.04	\$14.04	\$2.41	6	1.24%	100.00%
EnzyTech Multiple	\$14.04	\$14.04	\$14.04	\$0.00	0	0.00%	100.00%
Plant construction cost	\$14.04	\$14.04	\$14.04	\$0.00	0	0.00%	100.00%

Strategy 2		NPV					
	Low	Base	High	D	D ²	% Var	% Cum
DA Corp. markets	-\$3.04	\$8.95	\$30.51	\$33.55	1,126	53.53%	53.53%
Unit Revenue	-\$8.50	\$8.95	\$20.37	\$28.88	834	39.66%	93.20%
Demand Growth Rate	\$1.90	\$8.95	\$10.58	\$8.68	75	3.58%	96.78%
Production cost	\$12.78	\$8.95	\$5.06	\$7.71	59	2.83%	99.61%
Plant construction cost	\$10.01	\$8.95	\$7.14	\$2.86	8	0.39%	100.00%
EnzyTech Multiple	\$8.95	\$8.95	\$8.95	\$0.00	0	0.00%	100.00%

Strategy 3		NPV					
	Low	Base	High	D	D ²	% Var	% Cum
Unit Revenue	\$2.38	\$11.90	\$19.03	\$16.65	277	50.51%	50.51%
DA Corp. markets	\$4.76	\$11.90	\$19.10	\$14.34	206	37.43%	87.94%
Demand Growth Rate	\$7.44	\$11.90	\$12.90	\$5.46	30	5.42%	93.36%
Production cost	\$14.28	\$11.90	\$9.52	\$4.76	23	4.12%	97.48%
EnzyTech Multiple	\$9.67	\$11.90	\$13.38	\$3.72	14	2.52%	100.00%
Plant construction cost	\$11.90	\$11.90	\$11.90	\$0.00	0	0.00%	100.00%

Strategy 4		NPV					
	Low	Base	High	D	D ²	% Var	% Cum
DA Corp. markets	\$2.05	\$5.12	\$11.25	\$9.21	85	90.58%	90.58%
Demand Growth Rate	\$3.20	\$5.12	\$5.56	\$2.36	6	5.94%	96.53%
EnzyTech Multiple	\$4.16	\$5.12	\$5.75	\$1.60	3	2.73%	99.26%
Unit Revenue	\$4.64	\$5.12	\$5.47	\$0.83	1	0.74%	100.00%
Production cost	\$5.12	\$5.12	\$5.12	\$0.00	0	0.00%	100.00%
Plant construction cost	\$5.12	\$5.12	\$5.12	\$0.00	0	0.00%	100.00%

8.3 Value Model (Probabilistic)

Daylight Alchemy Corporation's Value Model (Prob)

Section 1 - Strategy Selection

Strategy		1	strategy
Strategy Name	No Partnership/ No		strategy_name
Strategy Descriptions			
1	No Partnership / No		
2	No Partnership / Expansion		
3	Joint Venture		
4	Royalty		

Section 2 - Constants

Description	Units	From Decision Tree	
		Value	Name
Real discount rate	%	8%	discount_rat
Tax	%	38%	tax_rate
Risk Tolerance	\$ million	30	risk_tol
Joint Venture Share	%	60.0%	JV_share
Royalty Payment	%	2.0%	Royalty
Current capacity	MM units	2.5	Capacity
Expansion	MM units	6	Expansion

Section 3 - Uncertainties

Section 5 - Uncertainties

Description	Units	Index	In Use	Name	From Decision Tree			
					Low	Base	High	
Demand uncertainties								
DA Corp. markets	MM units	2	2.8	dem_DAC	1.0	2.8	5.5	
EnzyTech Multiple	multiple	2	1.6	dem_ET	1.2	1.6	2.1	
Demand Growth Rate	%/ year	2	4%	growth_rate	-3%	4%	11%	
Revenue uncertainties								
Unit Revenue	\$/ unit	2	10.7	unit_revenu	9.95	10.70	11.38	
Cost uncertainties								
Production cost	\$/ unit	2	9.485	prod_cost	9.245	9.485	9.77	
Plant construction cost	\$ million	2	14.8	const_cost	13.6	14.8	16.15	

Section 4 - Calculations												
No Partnership / No Expansion												
Year Period			2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
			0	1	2	3	4	5	6	7	8	9
Sales												
	Demand DA Corp. Markets	MM units	2.75	2.85	2.95	3.06	3.17	3.28	3.40	3.52	3.65	3.78
	Demand EnzyTech Markets	MM units	4.43	4.59	4.75	4.92	5.10	5.28	5.47	5.67	5.88	6.09
	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 \$	26.75	26.75	26.75	26.75	26.75	26.75	26.75	26.75	26.75
Production Cost			MM \$	23.71	23.71	23.71	23.71	23.71	23.71	23.71	23.71	23.71
Plant Cost			MM \$	0.00								
JV Payment			MM \$	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
Earnings Before Tax			MM \$	3.04	3.04	3.04	3.04	3.04	3.04	3.04	3.04	3.04
Taxes			MM \$	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15
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
Tax Payment			MM \$	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15
Cash Flow			MM\$	1.88	1.88	1.88	1.88	1.88	1.88	1.88	1.88	1.88
Present Equivalent			MM 2020 \$	1.88	1.74	1.61	1.49	1.38	1.28	1.19	1.10	0.94
Net Present Value (NPV)			MM 2020 \$	13.65								

Section 4 - Calculations											
No Partnership / 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	2.75	2.85	2.95	3.06	3.17	3.28	3.40	3.52	3.65	3.78
Demand EnzyTech Markets	MM units	4.43	4.59	4.75	4.92	5.10	5.28	5.47	5.67	5.88	6.09
Capacity	MM units	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50
Sales	MM units	2.75	2.85	2.95	3.06	3.17	3.28	3.40	3.52	3.65	3.78
Revenue	MM \$	29.43	30.48	31.58	32.72	33.90	35.12	36.38	37.69	39.05	40.45
Production Cost	MM \$	26.08	27.02	28.00	29.00	30.05	31.13	32.25	33.41	34.61	35.86
Plant Cost	MM \$	14.80									
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 \$	-11.46	3.46	3.59	3.72	3.85	3.99	4.13	4.28	4.43	4.59
Taxes	MM \$	-4.35	1.32	1.36	1.41	1.46	1.52	1.57	1.63	1.68	1.75
Tax Credit Available for Next Year	MM \$	4.35	3.04	1.68	0.26	0.00	0.00	0.00	0.00	0.00	0.00
Tax Payment	MM \$	0.00	0.00	0.00	0.00	1.20	1.52	1.57	1.63	1.68	1.75
Cash Flow	MM\$	-11.46	3.46	3.59	3.72	2.65	2.47	2.56	2.65	2.75	2.85
Present Equivalent	MM 2020 \$	-11.46	3.21	3.07	2.95	1.95	1.68	1.61	1.55	1.49	1.42
Net Present Value (NPV)	MM 2020 \$	7.47									

Section 4 - Calculations												
Joint Venture												
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	2.75	2.85	2.95	3.06	3.17	3.28	3.40	3.52	3.65	3.78
	Demand EnzyTech Markets	MM units	4.43	4.59	4.75	4.92	5.10	5.28	5.47	5.67	5.88	6.09
	Capacity	MM units	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50
	Sales	MM units	4.43	4.59	4.75	4.92	5.10	5.28	5.47	5.67	5.88	6.09
Revenue												
	MM \$	47.37	49.08	50.85	52.68	54.57	56.54	58.57	60.68	62.87	65.13	
Production Cost												
	MM \$	41.99	43.51	45.07	46.70	48.38	50.12	51.92	53.79	55.73	57.73	
Plant Cost												
	MM \$	0.00										
JV Payment												
	MM \$	3.23	3.34	3.46	3.59	3.72	3.85	3.99	4.13	4.28	4.44	
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 \$	2.15	2.23	2.31	2.39	2.48	2.57	2.66	2.76	2.86	2.96	
Taxes												
	MM \$	0.82	0.85	0.88	0.91	0.94	0.98	1.01	1.05	1.09	1.12	
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 \$	0.82	0.85	0.88	0.91	0.94	0.98	1.01	1.05	1.09	1.12	
Cash Flow												
	MM\$	1.33	1.38	1.43	1.48	1.54	1.59	1.65	1.71	1.77	1.83	
Present Equivalent												
	MM 2020 \$	1.33	1.28	1.23	1.18	1.13	1.08	1.04	1.00	0.96	0.92	
Net Present Value (NPV)												
	MM 2020 \$	11.14										

Section 4 - Calculations												
Royalty												
Year Period			2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
			0	1	2	3	4	5	6	7	8	9
Sales												
	Demand DA Corp. Markets	MM units	2.75	2.85	2.95	3.06	3.17	3.28	3.40	3.52	3.65	3.78
	Demand EnzyTech Markets	MM units	4.43	4.59	4.75	4.92	5.10	5.28	5.47	5.67	5.88	6.09
	Capacity	MM units	4.43	4.59	4.75	4.92	5.10	5.28	5.47	5.67	5.88	6.09
	Sales	MM units	4.43	4.59	4.75	4.92	5.10	5.28	5.47	5.67	5.88	6.09
Revenue			MM \$	47.37	49.08	50.85	52.68	54.57	56.54	58.57	60.68	62.87
Production Cost			MM \$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Plant Cost			MM \$	0.00								
JV Payment			MM \$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Royalty Payment			MM \$	46.43	48.10	49.83	51.62	53.48	55.41	57.40	59.47	61.61
Earnings Before Tax			MM \$	0.95	0.98	1.02	1.05	1.09	1.13	1.17	1.21	1.26
Taxes			MM \$	0.36	0.37	0.39	0.40	0.41	0.43	0.45	0.46	0.48
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
Tax Payment			MM \$	0.36	0.37	0.39	0.40	0.41	0.43	0.45	0.46	0.48
Cash Flow			MM\$	0.59	0.61	0.63	0.65	0.68	0.70	0.73	0.75	0.81
Present Equivalent			MM 2020 \$	0.59	0.56	0.54	0.52	0.50	0.48	0.46	0.44	0.42
Net Present Value (NPV)			MM 2020 \$	4.91								

Data Tables

One-way Data Table for strategy

	Strategy	\$4.91
No Partnership / No Expansion	1	13.65
No Partnership / Expansion	2	7.47
Joint Venture	3	11.14
Royalty	4	4.91

Two-way Data Table for strategy and uncertainty level

DA Corp. markets			
\$4.91	1	2	3
1	\$5.98	\$13.65	\$13.65
2	-\$5.16	\$7.47	\$24.85
3	\$3.85	11.14	\$18.56
4	\$1.69	\$4.91	\$9.72

Enzy Tech Multiple			
\$4.91	1	2	3
1	\$13.65	\$13.65	\$13.65
2	\$7.47	\$7.47	\$7.47
3	\$7.96	\$11.14	\$14.19
4	\$3.50	\$4.91	\$6.25

Demand Growth Rate			
\$4.91	1	2	3
1	\$12.94	\$13.65	\$13.65
2	\$3.41	\$7.47	\$13.52
3	\$8.56	\$11.14	\$14.26
4	\$3.77	\$4.91	\$6.61

Unit Revenue			
\$4.91	1	2	3
1	\$5.22	\$13.65	\$21.29
2	-\$4.17	\$7.47	\$17.43
3	\$4.26	\$11.14	\$17.38
4	\$4.56	\$4.91	\$5.22

Production cost			
\$4.91	1	2	3
1	\$16.34	\$13.65	\$10.45
2	\$11.01	\$7.47	\$3.20
3	\$13.34	\$11.14	\$8.53
4	\$4.91	\$4.91	\$4.91

Plant construction cost			
\$4.91	1	2	3
1	\$13.65	\$13.65	\$13.65
2	\$8.33	\$7.47	\$6.50
3	\$11.14	\$11.14	\$11.14
4	\$4.91	\$4.91	\$4.91

DA Markets

Unit Revenue

From Value Model (s1), (s2), (s3) and (s4) sheets

Two-way Data Table for DA Market and Unit Revenue

Strategy	1	2	3
1	\$13.65	\$2.29	\$5.98
2	\$5.22	\$13.65	\$21.29
3	\$5.22	\$13.65	\$21.29

Strategy	2	1	2	3
\$7.47				
1	-\$11.11	-\$5.16	-\$1.07	
2	-\$4.17	\$7.47	\$17.43	
3	\$3.07	\$24.85	\$44.18	

Strategy	3	1	2	3
\$11.14				
1	\$1.47	\$3.85	\$6.00	
2	\$4.26	\$11.14	\$17.38	
3	\$7.10	\$18.56	\$28.95	

Strategy	4	1	2	3
\$4.91				
1	\$1.58	\$1.69	\$1.80	
2	\$4.56	\$4.91	\$5.22	
3	\$9.04	\$9.72	\$10.34	

8.4 Sensitivity Analysis

Risk Tolerance (ρ)	Risk Aversion (γ)	Strategy1	Strategy2	Strategy3	Strategy4	Best
-\$0.10	-10	\$21.12	\$43.90	\$28.67	\$9.59	Strategy2
-\$0.11	-9	\$21.10	\$43.87	\$28.64	\$9.57	Strategy2
-\$0.13	-8	\$21.08	\$43.83	\$28.60	\$9.55	Strategy2
-\$0.14	-7	\$21.05	\$43.78	\$28.55	\$9.53	Strategy2
-\$0.17	-6	\$21.01	\$43.72	\$28.49	\$9.49	Strategy2
-\$0.20	-5	\$20.95	\$43.63	\$28.39	\$9.45	Strategy2
-\$0.25	-4	\$20.87	\$43.49	\$28.26	\$9.38	Strategy2
-\$0.33	-3	\$20.73	\$43.26	\$28.02	\$9.26	Strategy2
-\$0.50	-2	\$20.45	\$42.79	\$27.56	\$9.03	Strategy2
-\$1.00	-1	\$19.61	\$41.41	\$26.18	\$8.35	Strategy2
-\$1.11	-0.9	\$19.43	\$41.10	\$25.87	\$8.21	Strategy2
-\$1.25	-0.8	\$19.20	\$40.71	\$25.48	\$8.04	Strategy2
-\$1.43	-0.7	\$18.91	\$40.22	\$24.99	\$7.84	Strategy2
-\$1.67	-0.6	\$18.53	\$39.56	\$24.34	\$7.60	Strategy2
-\$2.00	-0.5	\$18.03	\$38.63	\$23.44	\$7.31	Strategy2
-\$2.50	-0.4	\$17.34	\$37.25	\$22.15	\$6.97	Strategy2
-\$3.33	-0.3	\$16.39	\$34.96	\$20.24	\$6.59	Strategy2
-\$5.00	-0.2	\$15.09	\$30.58	\$17.49	\$6.17	Strategy2
-\$10.00	-0.1	\$13.41	\$21.09	\$14.09	\$5.73	Strategy2
-\$11.11	-0.09	\$13.23	\$19.76	\$13.75	\$5.69	Strategy2
-\$12.50	-0.08	\$13.05	\$18.37	\$13.41	\$5.65	Strategy2
-\$14.29	-0.07	\$12.86	\$16.96	\$13.08	\$5.60	Strategy2
-\$16.67	-0.06	\$12.68	\$15.55	\$12.76	\$5.56	Strategy2
-\$20.00	-0.05	\$12.49	\$14.16	\$12.45	\$5.52	Strategy2
-\$25.00	-0.04	\$12.30	\$12.82	\$12.14	\$5.47	Strategy2
-\$33.33	-0.03	\$12.12	\$11.54	\$11.85	\$5.43	Strategy1
-\$50.00	-0.02	\$11.93	\$10.33	\$11.56	\$5.39	Strategy1
-\$100.00	-0.01	\$11.74	\$9.21	\$11.28	\$5.35	Strategy1
\$10,000.00	0.0001	\$11.56	\$8.17	\$11.01	\$5.31	Strategy1
\$100.00	0.01	\$11.38	\$7.23	\$10.75	\$5.27	Strategy1
\$50.00	0.02	\$11.20	\$6.36	\$10.51	\$5.23	Strategy1
\$33.33	0.03	\$11.02	\$5.57	\$10.27	\$5.19	Strategy1
\$25.00	0.04	\$10.85	\$4.84	\$10.04	\$5.15	Strategy1
\$20.00	0.05	\$10.68	\$4.18	\$9.82	\$5.11	Strategy1
\$16.67	0.06	\$10.51	\$3.57	\$9.61	\$5.07	Strategy1
\$14.29	0.07	\$10.35	\$3.00	\$9.41	\$5.03	Strategy1
\$12.50	0.08	\$10.19	\$2.48	\$9.21	\$4.99	Strategy1
\$11.11	0.09	\$10.03	\$2.00	\$9.03	\$4.95	Strategy1
\$10.00	0.1	\$9.88	\$1.56	\$8.85	\$4.92	Strategy1
\$5.00	0.2	\$8.57	-\$1.64	\$7.44	\$4.57	Strategy1
\$3.33	0.3	\$7.62	-\$3.57	\$6.50	\$4.26	Strategy1
\$2.50	0.4	\$6.92	-\$4.90	\$5.84	\$4.00	Strategy1
\$2.00	0.5	\$6.39	-\$5.88	\$5.35	\$3.77	Strategy1
\$1.67	0.6	\$5.97	-\$6.63	\$4.97	\$3.57	Strategy1
\$1.43	0.7	\$5.63	-\$7.22	\$4.65	\$3.40	Strategy1
\$1.25	0.8	\$5.34	-\$7.68	\$4.39	\$3.25	Strategy1
\$1.11	0.9	\$5.09	-\$8.04	\$4.16	\$3.12	Strategy1
\$1.00	1	\$4.87	-\$8.34	\$3.97	\$3.00	Strategy1
\$0.50	2	\$3.67	-\$9.72	\$2.85	\$2.39	Strategy1
\$0.33	3	\$3.21	-\$10.19	\$2.40	\$2.16	Strategy1
\$0.25	4	\$2.98	-\$10.42	\$2.17	\$2.04	Strategy1
\$0.20	5	\$2.84	-\$10.56	\$2.03	\$1.97	Strategy1
\$0.17	6	\$2.75	-\$10.65	\$1.94	\$1.93	Strategy1
\$0.14	7	\$2.68	-\$10.71	\$1.87	\$1.89	Strategy1
\$0.13	8	\$2.63	-\$10.76	\$1.82	\$1.87	Strategy1
\$0.11	9	\$2.60	-\$10.80	\$1.78	\$1.85	Strategy1
\$0.10	10	\$2.56	-\$10.83	\$1.75	\$1.83	Strategy1
\$0.09	11	\$2.54	-\$10.86	\$1.73	\$1.82	Strategy1
\$0.08	12	\$2.52	-\$10.88	\$1.70	\$1.81	Strategy1

Real Discount Rate	Strategy1	Strategy2	Strategy3	Strategy4	Best
	\$10.97	\$5.32	\$10.19	\$5.17	Strategy 1
0%	\$14.88	\$11.58	\$13.86	\$7.22	Strategy 1
1%	\$14.28	\$10.62	\$13.29	\$6.90	Strategy 1
2%	\$13.71	\$9.72	\$12.76	\$6.60	Strategy 1
3%	\$13.17	\$8.88	\$12.26	\$6.32	Strategy 1
4%	\$12.68	\$8.08	\$11.80	\$6.06	Strategy 1
5%	\$12.21	\$7.33	\$11.36	\$5.82	Strategy 1
6%	\$11.77	\$6.62	\$10.94	\$5.59	Strategy 1
7%	\$11.35	\$5.95	\$10.56	\$5.37	Strategy 1
8%	\$10.97	\$5.32	\$10.19	\$5.17	Strategy 1
9%	\$10.60	\$4.72	\$9.85	\$4.98	Strategy 1
10%	\$10.26	\$4.16	\$9.52	\$4.81	Strategy 1
11%	\$9.93	\$3.62	\$9.22	\$4.64	Strategy 1
12%	\$9.63	\$3.12	\$8.93	\$4.49	Strategy 1
13%	\$9.34	\$2.64	\$8.66	\$4.34	Strategy 1
14%	\$9.06	\$2.19	\$8.40	\$4.20	Strategy 1
15%	\$8.81	\$1.75	\$8.16	\$4.07	Strategy 1
16%	\$8.56	\$1.35	\$7.92	\$3.95	Strategy 1

Tax Rate	Strategy1	Strategy2	Strategy3	Strategy4	Best
	\$10.97	\$5.32	\$10.19	\$5.17	Strategy 1
0%	\$17.12	\$8.93	\$15.71	\$8.21	Strategy 1
5%	\$16.34	\$8.50	\$15.01	\$7.82	Strategy 1
10%	\$15.54	\$8.06	\$14.30	\$7.42	Strategy 1
15%	\$14.74	\$7.61	\$13.59	\$7.02	Strategy 1
20%	\$13.93	\$7.14	\$12.87	\$6.62	Strategy 1
25%	\$13.12	\$6.65	\$12.14	\$6.22	Strategy 1
30%	\$12.30	\$6.15	\$11.39	\$5.82	Strategy 1
35%	\$11.47	\$5.64	\$10.64	\$5.42	Strategy 1
40%	\$10.63	\$5.10	\$9.89	\$5.01	Strategy 1
45%	\$9.79	\$4.55	\$9.12	\$4.60	Strategy 1
50%	\$8.93	\$3.98	\$8.34	\$4.19	Strategy 1
55%	\$8.08	\$3.39	\$7.55	\$3.78	Strategy 1
60%	\$7.21	\$2.78	\$6.75	\$3.37	Strategy 1

Joint Venture Share	Strategy1	Strategy2	Strategy3	Strategy4
	\$10.97	\$5.32	\$10.19	\$5.17
0%	\$10.97	\$5.32	\$22.88	\$5.17
5%	\$10.97	\$5.32	\$21.92	\$5.17
10%	\$10.97	\$5.32	\$20.95	\$5.17
15%	\$10.97	\$5.32	\$19.96	\$5.17
20%	\$10.97	\$5.32	\$18.95	\$5.17
25%	\$10.97	\$5.32	\$17.92	\$5.17
30%	\$10.97	\$5.32	\$16.88	\$5.17
35%	\$10.97	\$5.32	\$15.81	\$5.17
40%	\$10.97	\$5.32	\$14.73	\$5.17
45%	\$10.97	\$5.32	\$13.63	\$5.17
50%	\$10.97	\$5.32	\$12.50	\$5.17
55%	\$10.97	\$5.32	\$11.36	\$5.17
60%	\$10.97	\$5.32	\$10.19	\$5.17
65%	\$10.97	\$5.32	\$9.00	\$5.17
70%	\$10.97	\$5.32	\$7.79	\$5.17

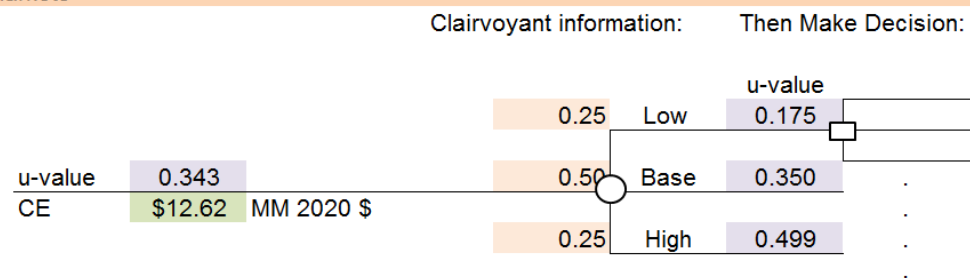
Royalty Payment	Strategy1	Strategy2	Strategy3	Strategy4	Best
	\$10.97	\$5.32	\$10.19	\$5.17	Strategy 1
0%	\$10.97	\$5.32	\$10.19	\$0.00	Strategy 1
1%	\$10.97	\$5.32	\$10.19	\$2.62	Strategy 1
2%	\$10.97	\$5.32	\$10.19	\$5.17	Strategy 1
3%	\$10.97	\$5.32	\$10.19	\$7.66	Strategy 1
4%	\$10.97	\$5.32	\$10.19	\$10.08	Strategy 1
5%	\$10.97	\$5.32	\$10.19	\$12.45	Strategy 4
6%	\$10.97	\$5.32	\$10.19	\$14.75	Strategy 4
7%	\$10.97	\$5.32	\$10.19	\$16.99	Strategy 4
8%	\$10.97	\$5.32	\$10.19	\$19.18	Strategy 4
9%	\$10.97	\$5.32	\$10.19	\$21.31	Strategy 4
10%	\$10.97	\$5.32	\$10.19	\$23.39	Strategy 4

Current Capacity	Strategy1	Strategy2	Strategy3	Strategy4	Best
	\$10.97	\$5.32	\$10.19	\$5.17	Strategy 1
0	\$0.00	\$5.04	\$9.16	\$5.17	Strategy 3
0.5	\$2.67	\$5.20	\$9.38	\$5.17	Strategy 3
1	\$5.28	\$5.29	\$9.59	\$5.17	Strategy 3
1.5	\$7.34	\$5.32	\$9.80	\$5.17	Strategy 3
2	\$9.19	\$5.32	\$10.00	\$5.17	Strategy 3
2.5	\$10.97	\$5.32	\$10.19	\$5.17	Strategy 1
3	\$12.54	\$5.32	\$10.37	\$5.17	Strategy 1
3.5	\$13.51	\$5.32	\$10.50	\$5.17	Strategy 1
4	\$14.08	\$5.32	\$10.60	\$5.17	Strategy 1
4.5	\$14.54	\$5.32	\$10.67	\$5.17	Strategy 1
5	\$14.97	\$5.32	\$10.72	\$5.17	Strategy 1
5.5	\$15.35	\$5.32	\$10.75	\$5.17	Strategy 1
6	\$15.62	\$5.32	\$10.77	\$5.17	Strategy 1

Expansion	Strategy1	Strategy2	Strategy3	Strategy4	Best
	\$10.97	\$5.32	\$10.19	\$5.17	Strategy 1
0	\$10.97	\$0.18	\$4.90	\$5.17	Strategy 1
1	\$10.97	\$2.93	\$6.42	\$5.17	Strategy 1
2	\$10.97	\$3.97	\$7.88	\$5.17	Strategy 1
3	\$10.97	\$4.78	\$8.86	\$5.17	Strategy 1
4	\$10.97	\$5.20	\$9.38	\$5.17	Strategy 1
5	\$10.97	\$5.32	\$9.80	\$5.17	Strategy 1
6	\$10.97	\$5.32	\$10.19	\$5.17	Strategy 1
7	\$10.97	\$5.32	\$10.50	\$5.17	Strategy 1
8	\$10.97	\$5.32	\$10.67	\$5.17	Strategy 1
9	\$10.97	\$5.32	\$10.75	\$5.17	Strategy 1
10	\$10.97	\$5.32	\$10.77	\$5.17	Strategy 1
11	\$10.97	\$5.32	\$10.77	\$5.17	Strategy 1
12	\$10.97	\$5.32	\$10.77	\$5.17	Strategy 1

8.5 Value of Information and Control

Uncertainty: DA Corp. markets



Uncertainty: Unit Revenue

