MOD500 project

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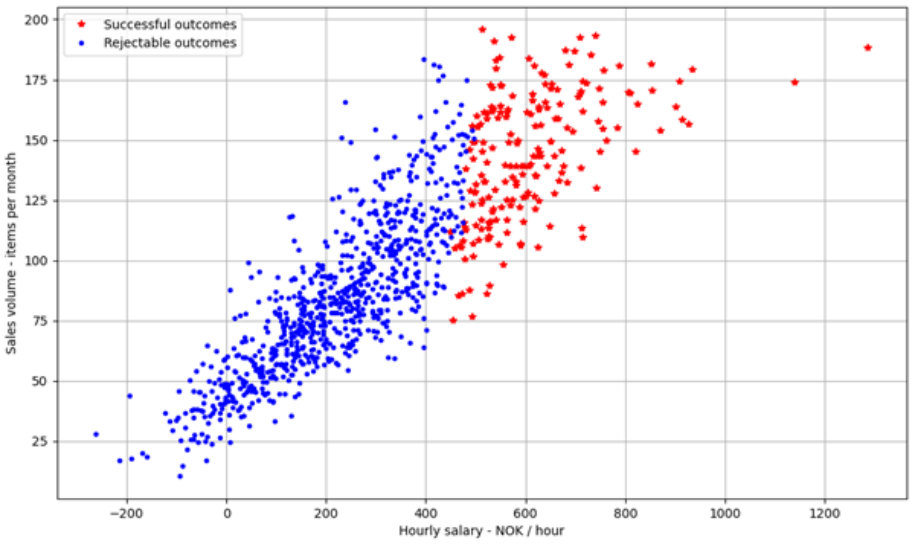

Figure 1: Hourly Salary

Abstract

Startups in the early phase, have different characteristics than mature companies. This project aims to provide an in-depth analysis of the current company status to cut through much of the confusion and help identify the real problem. Hence, owners decide whether to stop the business or continue with a margin of uncertainty. They would expect profit ranges from 20,000 NOK if they don't have to work and 80,000 NOK if they worked their maximum designated amount of hours a month.

This analysis provides a normative approach that can support the owners. The decision basis is composed of the answers to three questions: What are the possible alternatives? What information do I have to describe these alternatives? What value (decision criterion) do I want to use to choose between the alternatives? When the decision basis is developed, the underlying problem is usually well-identified [1].

A Monte Carlo simulation and decision making theory was implemented as a framework to help the business owners make the best decision based on their own preferences.

After running the numbers through our models, the one year prospect for the company was positive - given the risk seeking attitude of the owners. The decision would be to run the market analysis, and if the result was positive the company would be run for another year, if the result of the market research turned out negative the company would be dissolved. It is worth mentioning that for a risk-neutral attitude the resulting expected value for running the company for another year, with or without the market research is negative.

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1 Introduction

This project explores why a fictional startup company's product has problems. Market research was conducted before the COVID-19 pandemic, and the market launch came after. All estimates were good regarding how the product would perform on the market, but post-launch profits were lacking. Now the company either abandons the project or move forward for another year, hoping for positive change.

As of now the company is run by the two owners. Their goal is to work as little as possible while earning as much as possible. To achieve this, they arranged with the production company and the shipping company to get a discounted price on orders over a certain amount. As for production, the initial cost of 500 NOK for a single product was contracted to be reduced by 0.5 NOK multiplied by the number of products ordered. The shipping offer states that amounts over 100 will be reduced from 450 NOK to 350 NOK per item. In addition, working hours exceeding 160 hours per person per month, totaling 320 hours for both, are outsourced to consultants at 400 NOK per hour.

To make an informed decision, they hired another consulting firm to mainly analyze relevant variables such as sales price and volume, marketing, workload, and labor force per item sold. Next, the owners were asked how much they could earn because of their service. They expect to earn 20,000 NOK if they don't have to work, 25,000 NOK for 40 hours, 35,000 NOK for 80 hours, and if they worked their maximum designated amount of 160 hours a month, they would want to make 80,000 NOK.

1.1 Structure

Variables

The section variables lists the variables used for the project. It also explains a little about how they vary based on external factors.

Risk Attitude

Risk attitude has a focus on the company's risk preferences. What is their risk tolerance, are they risk seeking or risk averse, etc.

Sensitivity Analysis

In the section sensitivity analysis the focus lies on determining how important each variable is to the end result, in order to figure out which of them to perform market research on.

Market Research Sales Volume

After having figured out which variable to focus on this section, takes this variable and does a market research to determine if it is worth continuing with the company.

Discussion

In the section discussion a model appraisal is performed along with a short explanation of using a fixed seed for generating the data used in the project.

Conclusion

The conclusion goes over every result and how the company owners reacted to each of them.

2 Variables

2.1 Sales Price

The variation in sales price is roughly equivalent to a triangular distribution with minimum 1600 NOK, mode 2000 NOK, and maximum 2400 NOK. This variation is caused by the desire to keep the price as high as possible, but there are competing products on the market forcing the price to change every now and then.

2.2 Sales Volume

Sales volume refers to how many items are sold every month. To model it a triangular distribution with min 10, mode 80, and max 200 is used. The variation represents miss marketing, price not appropriate compared to competitors, or other unforeseen reasons.

2.3 Marketing

Marketing uses a triangular distribution with min 20,000 NOK, mode 40,000 NOK, and max 50,000 NOK. It measures how much the company is willing or able to provide to marketing each month.

2.4 Base Workload

Base workload tells how many hours the two partners put into the company combined. To represent this a triangular distribution with min 100, mode 150, and max 300 is used. These hours can't be outsourced to a consultant company, so if an unexpected problem occurs they need to handle it themselves.

2.5 Work per Sold Item

As opposed to base workload, work per sold item can be outsourced. They try not to do it, but over 320 total hours they still do. With every item there is a chance that there is a complaint. This is represented with a triangular distribution with min 0.1, mode 0.5, and max 1 in hours.

3 Risk Attitude

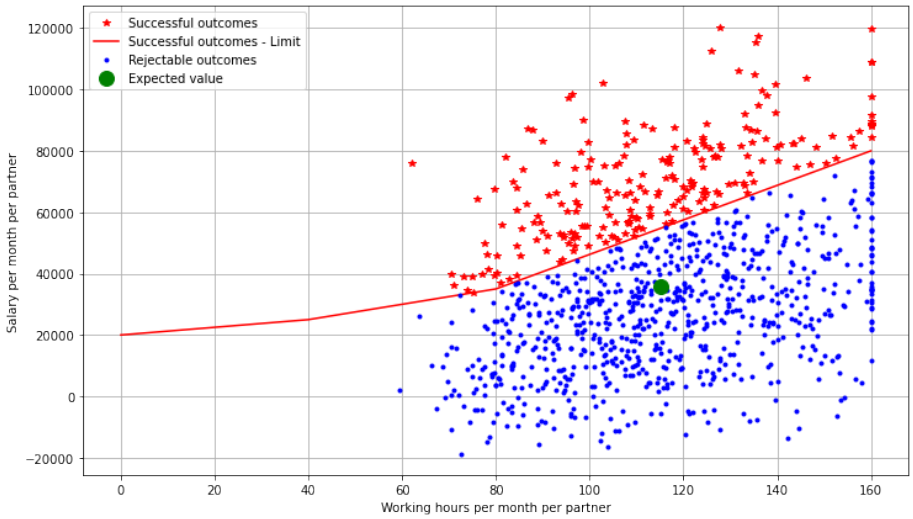

Figure 2: MC scatter

	Base case
mode	80
p	0.194
V_good	30341
V_bad	-14937

Figure 3: Results Base Case

While presented with these results the partners express a slight concern. They are almost at the point where they would like to continue, but these odds are a little too bad. When asked to quantify their position they arrived at evaluating the certain equivalent of the situation at -1000 NOK / month. With these inputs we can quantify the risk tolerance of the partners:

Risk tolerance		-38269.1		
Value		Value	Utility	
30341	0.194	5886.154	-1.209648713	-0.23467
-14937	0.806	-12039.2	0.323156528	0.260464
	Sum utility			0.025792
	Convert to value			-1000

Figure 4: Risk Tolerance Calculation

$$U(X) = 1 - e^{\frac{-X}{-38269}}$$

The risk neutral evaluation of the results would yield a certain equivalent (expected value) of about 6k NOK / month. A risk tolerance of -38k tells us that the partners are risk seekers. They value the potential positive outcome higher than the negative one.

Figure 5: Decision Tree Base Values

The partners experience the outlook as having a negative expected value. They have shown risk-seeking behaviour, but not to a high enough degree to go ahead with the current prognosis. We want to see if we can gather some information to reduce the uncertainty.

We have seen from sensitivity analysis that most uncertainty is tied to how well the product will sell. The number of sold products are also strongly correlated with the success of the endeavour. So we will focus our efforts into updating this uncertainty.

4 Sensitivity Analysis

The owners are not quite happy with the expected value of continuing with the product and have asked if it is possible to improve this. Performing a market analysis for one or more of the unknown variables is a good way of improving the decision making. In order to figure out which variables to focus on, a sensitivity analysis is performed for each variable.

4.1 Sales Price

Looking at the acceptable outcomes of the sales price provides an idea of how sensitive it is. For the histogram, figure 6, it can be observed that the acceptable outcomes have more or less the same trend as the full dataset. The higher the price the more acceptable outcomes.

When looking at the error bar, figure 7, it can be observed that the standard that full dataset and the acceptable outcomes are not to different. The standard deviation of the full dataset is about 175 with a mean of 2000, while the acceptable outcomes has standard deviation of 125 and mean 2060. Overall this raises the lower end a bit but the higher is about the same. This makes it not to sensitive.

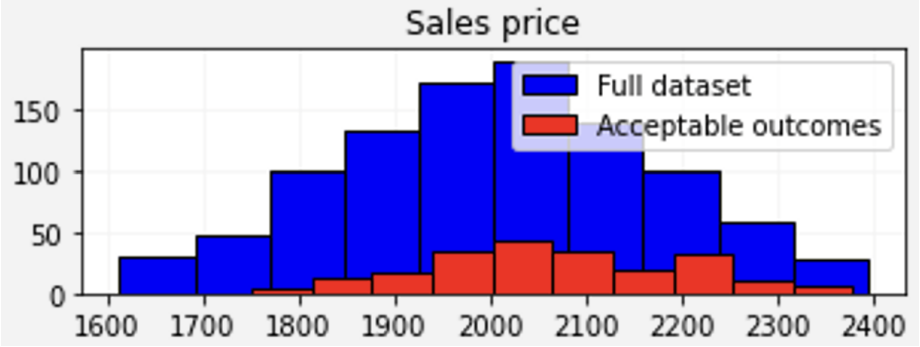

Figure 6: Histogram Sales Price

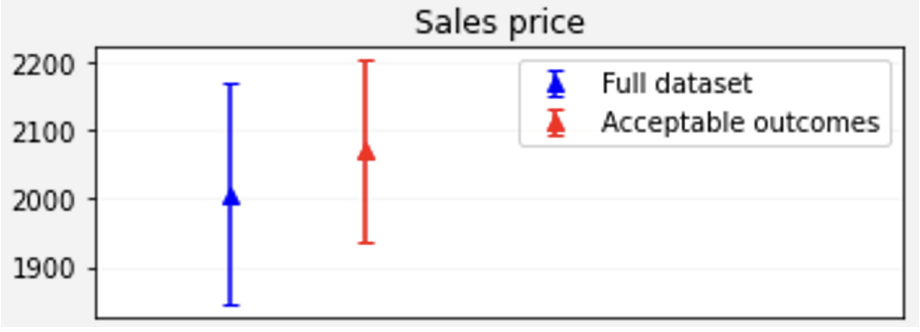

Figure 7: Error Bar Sales Price

4.2 Sales Volume

As opposed to the sales price, the acceptable outcomes for sales volume have a similar trend to the full dataset, but they have been shifted to far higher values. This is the case for both the histogram plot, figure 8, and the error bar plot, figure 9. For this variable it would be desired to get a sales volume outside the standard deviation in order to achieve a good result. Due to that fact, sales volume is a variable that would be quite valuable to obtain more information on.

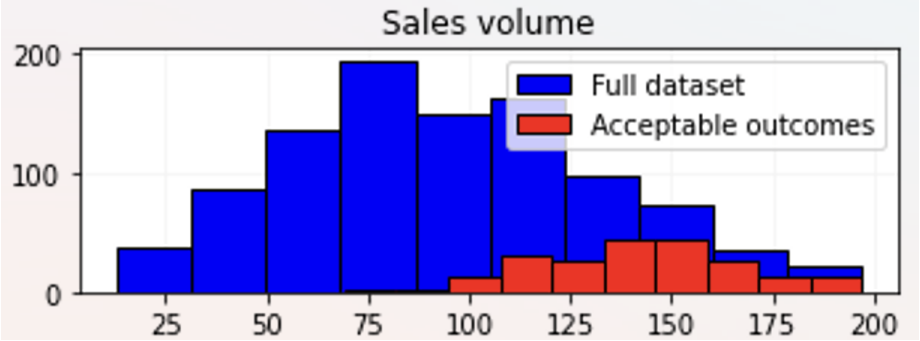

Figure 8: Histogram Sales Volume

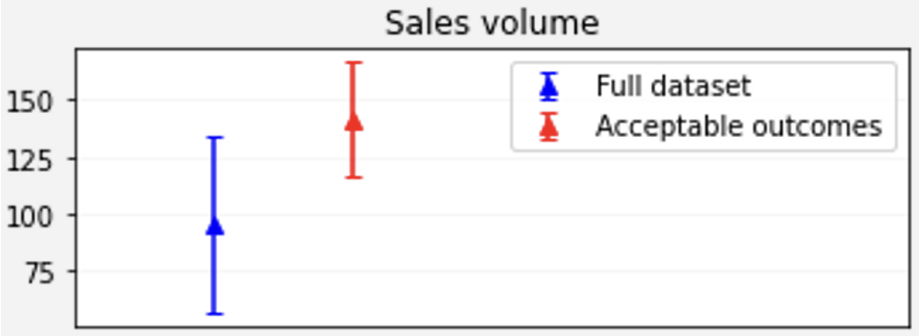

Figure 9: Error Bar Sales Volume

4.3 Marketing Cost

Acceptable outcomes for marketing cost cover are almost the same trend as the full dataset on the histogram, figure 10. The variation on the error bar, figure 11, is negligible. For the upper end of the standard deviation the difference is maybe 500 NOK on a scale of tens of thousands, and the same for lower. This makes it not as worth performing a market analysis for marketing.

Figure 10: Histogram Marketing Cost

Figure 11: Error Bar Marketing Cost

4.4 Base Workload

When it comes to workload it is to an extent the owners decision to work more or less that affects the result the most. Graphically it is similar to how sales price is, just inverted. Based on this it is not worth spending much research on workload.

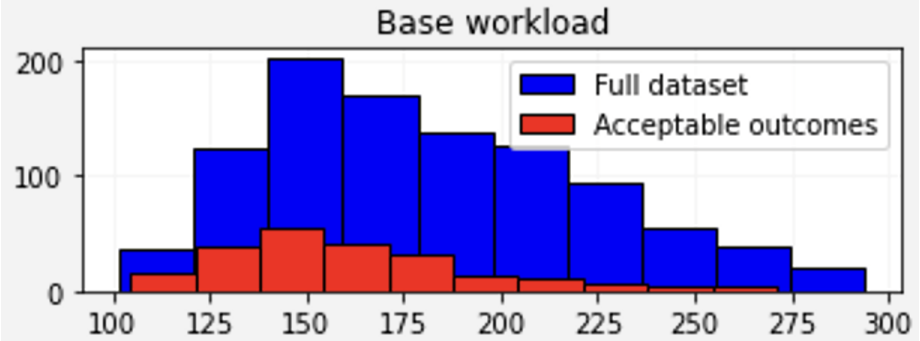

Figure 12: Histogram Workload

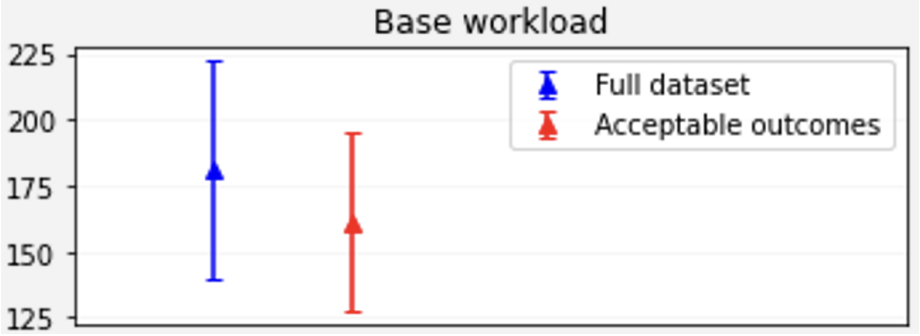

Figure 13: Error Bar Workload

4.5 Work per Sold Item

Work per item is graphically almost the same as workload. Both the plots show similar trend for acceptable outcomes and the full dataset.

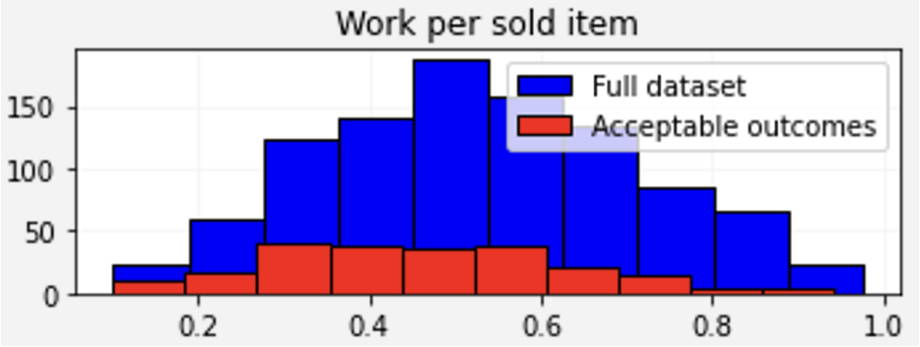

Figure 14: Pole Work per Item Sold

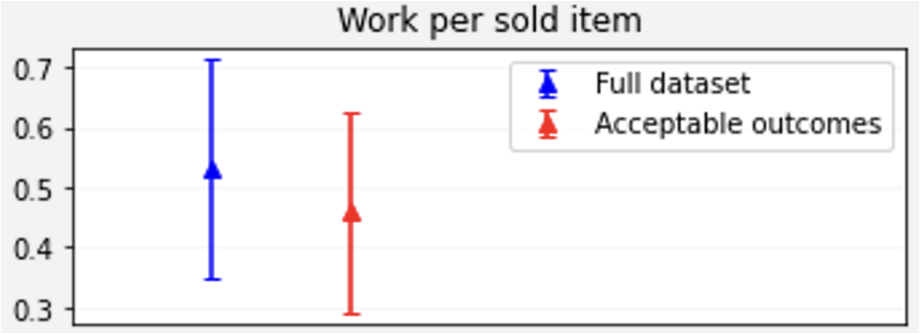

Figure 15: Arrow Work per Item Sold

4.6 Analysis Result

Since the only variable that appears to differ drastically from the full dataset is sales volume, that is the variable that will be investigated further. While the others could cause changes, they are deemed to be of a lesser degree than sales volume, and therefore not as important. If other variables were to be investigated, base workload and sales price would be the best candidates. Based on the results at hand, marketing cost does not appear to be to have much of an impact.

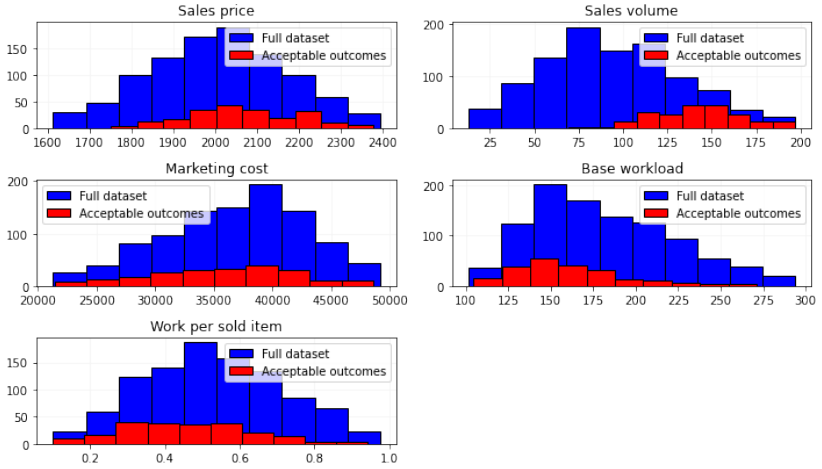

Figure 16: Histogram All Variables

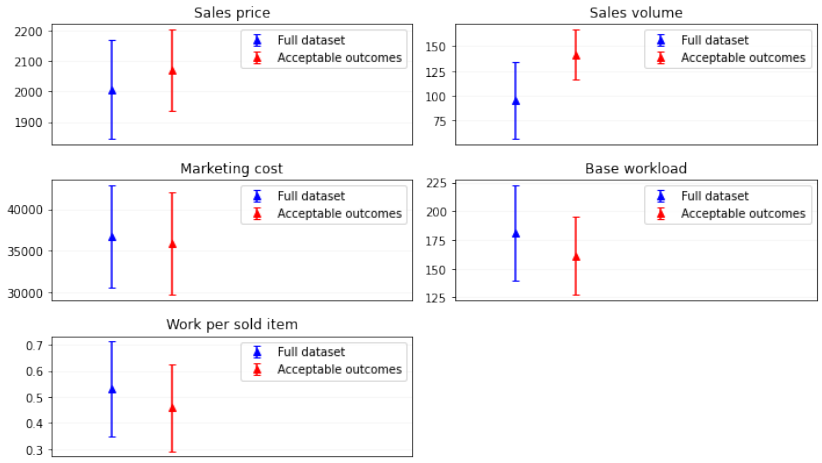

Figure 17: Error Bar All Variables

5 Market Research on Sales Volume

A company specializing in market analysis can offer the following 'test':

- The test will be either 'Positive', or 'Negative', indicating whether the sales volume prognosis is better or worse than the base case initially assumed.
- Based on experience the company says that the test is 40% likely to give a Positive result, meaning the mode sales volume changes to 120 items sold per month. For a Negative result the mode sales volume will decrease to 40.
- The test costs 30k NOK.

We re-run the Monte Carlo analysis to determine the updated chances for success and the corresponding value of information:

Sales Volume			
	Base case	Negative	Positive
Mode sales volume	80	40	120
Probability of 'success'	0.194	0.138	0.278
Mean value in case of success	30341	30322	31595
Mean value if not successful	-14937	-22397	-9808

Figure 18: Sales Volume

These results will be used to form a new decision tree. Since the scope of the decision is whether to continue running the company for another year, we transform the cost of the market analysis from 30000 (NOK per year) to 1250 (NOK per partner per month) by dividing by (2*12). After factoring in the cost of the market analysis 'test' and applying the utility function to the values, the decision tree looks as follows:

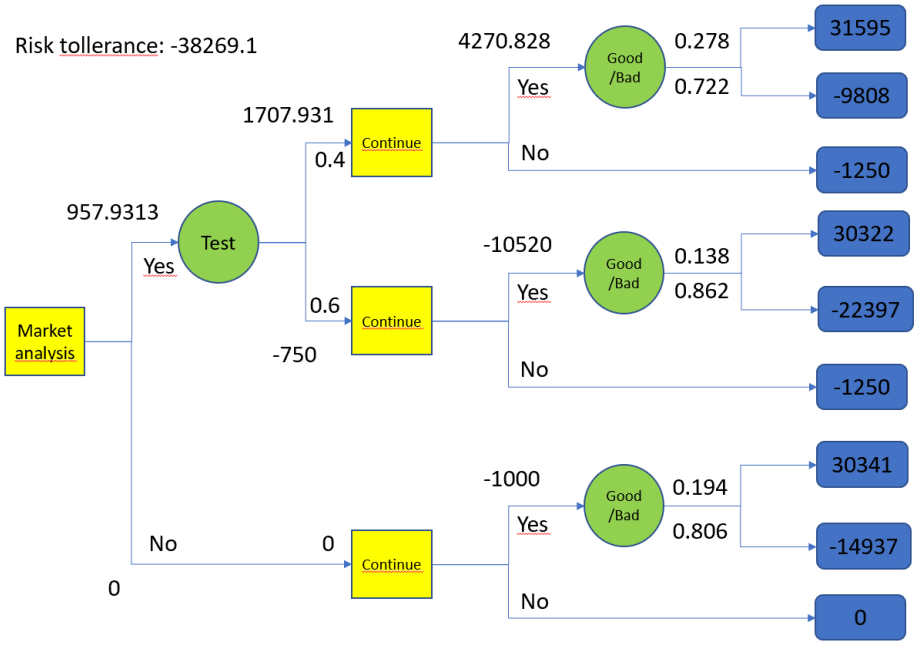

Figure 19: Decision Tree Risk Seeker

Once the decision tree was constructed, the decision is easy enough to make. If the market analysis comes back 'Positive', the partners should run the company for another year. In the opposite case the company should be dissolved immediately.

The certain equivalent of the full decision tree is now 957 NOK per month, which in case is the value of information. This result is based on the risk attitude of the partners. Here it is important to remember that the result is only a 'win' in the subjective view of the partners. For a risk neutral attitude the result would be different.

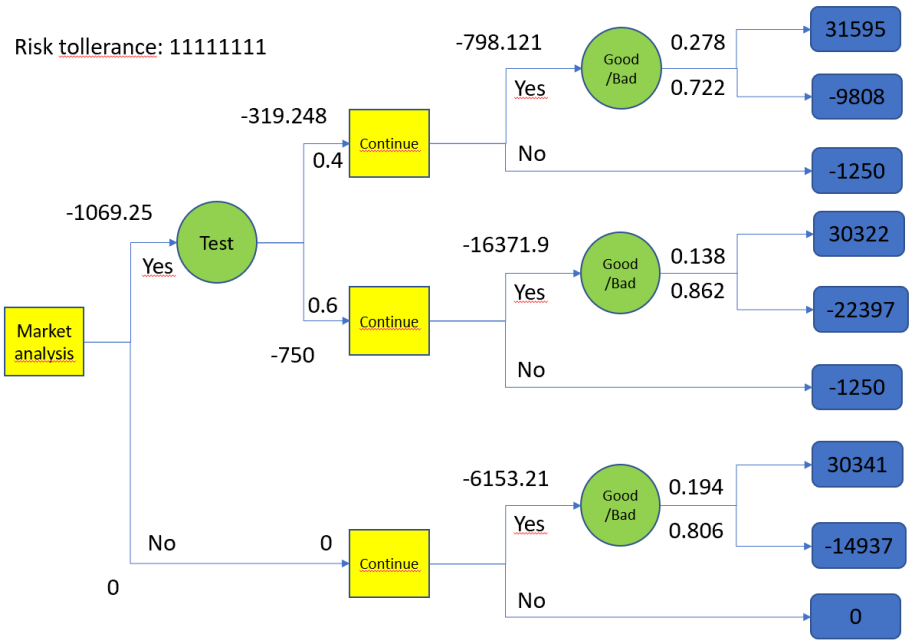

Figure 20: Decision Tree Risk Neutral

By calculating new certain equivalent values for an "infinite" risk tolerance, we approach risk neutral behaviour where certain equivalent is equal to expected value. From the risk neutral decision tree, we see that all outcomes downstream of choosing to perform the market analysis are worse than choosing to dissolve the company. So, what is the 'correct' decision?

About 90% of startups fail. 10% of startups fail within the first year, and 80% within 5 years. Across all industries, startup failure rates seem to be close to the same [2]. Maybe the expected value from the 10% that succeed outweigh the cost of the 90% that fail. In that case – as a society – it makes sense to stimulate for innovation and start ups. It is hard to imagine that the world would continue economic growth without risk seeking individuals defying the odds in pursuit of huge gains.

The 'logical' advice is to be risk neutral in decision making. However without people defying the odds and making an attempt at success, nobody would succeed for sure. Whether a startup succeeds, should not feel as a personal failure, and as research has shown, being lucky is more important than hard work [3]. Working hard and making smart choices is certainly important, but in many cases the 'smart' choice will be a conservative one. While it is not possible to be a million times smarter, or work a million times harder than someone else, it is certainly possible to earn a million times more.

6 Discussion

6.1 Model Appraisal

This model appraisal performed with the help of the decision quality chain presented in the document Decision Quality - The Fundamentals of Making Good Decisions [4].

Helpful Frame

The decision includes the biggest variables affecting success, and the risk attitude of the decision makers. At the same time, limiting the extent of the decision to one year. Past this time frame, long term variable becomes difficult to predict. Therefore the return on investment needs to become apparent within a year. The five main variables have no dependency in the model, but in real life this would likely be the case.

Clear Values

The decision makers definition of success and their risk attitude, have been taken into account. Earn as much as possible without working to much. The owners of the company were asked how much they want to earn versus how many hours they worked. Using different sets of preferences would change the definition of success and alter the risk attitudes, and thereby affect the results.

Creative Alternatives

We chose to pursue the alternative of performing a market research toward the most critical variable for success. Their options are to continue, terminate, or perform test then decide. Other options were considered, but ultimately deemed as either unrealistic, or otherwise not in flavor for the project:

- Adding a second product. This could reduce the exposure to the success for a single product.
- One of the partners left the company and the other carried on. While this is an option it is not necessarily a good option as they would lose the dynamic that made the company work.
- Drastically reducing the price of the product in other to take over the market. While an interesting idea it is unlikely to work due to the amount of competitors and their previous sales volume.

Useful Information

The starting information that was provided for the simulation had various degrees of impact on the decision to be made. Therefore a market analysis of sales volume was performed. An analysis of the other variables could give more useful information but they were considered to be less impactful.

Sound Reasoning

The decision is more or less made by the Monte-Carlo simulation and the excel spreadsheet calculations. Personal feeling don't really get involved aside from risk attitude, which is accounted for in the calculations. This means that the decision is logically sound as long as the calculations we make are correct. As a base quality assurance we have observed that changing input parameters pushes results in the intuitive direction.

Commitment to Follow Through

This is not entirely relevant in a theoretical scenario. In the real world there are other factors like sunk cost that would feel relevant to a decision maker, even though it is not. This can include both money and time.

Overall

Creative alternatives is the topic that has the most room for improvement. If the scope of the project was to be increased that is a good point to start looking for different options.

6.2 Random Seed

When running the model a fixed seed was used. This was done to guarantee that every result could be replicated exactly. Using a strictly random seed doesn't produce a too dissimilar result, variation from max to min less than 1%. This variation could be reduced by increasing the amount of nodes generated. In conclusion a random seed wouldn't change the outcome of the project, only the numbers produced.

7 Conclusion

Initially studied parameters include sales price and volume, marketing, base workload, and additional work per sold item. Then, risk attitude of stakeholders was identified with the help of a questionnaire and risk tolerance calculated to about -38,000. The result indicated the stakeholders as risk seekers, but the initial prospect was still not promising enough for them to pursue. Sensitivity analysis showed that sales volume had the greatest impact on the success of the business venture. A market analysis was available for purchase that would update the expected sales volume in either positive or negative direction. The new decision to make was whether to perform the market analysis or not, whether the value of information provided by the research exceeded its cost.

After running the numbers through our models, the one year prospect for the company was positive - given the risk seeking attitude of the owners. The decision would be to run the market analysis, and if the result was positive the company would be run for another year, if the result of the market research turned out negative the company would be dissolved. It is worth mentioning that for a risk-neutral attitude the resulting expected value for running the company for another year, with or without the market research is negative.

References

[1] P. McNamee and J. Celona, *Decision Analysis for the Professional*, Fourth Edition. SmartOrg, 2001, ISBN: 0-9710569-0-0.

[2] E. Team. "106 must-know startup statistics for 2022." (Oct. 25, 2022), [Online]. Available: `https://www.embroker.com/blog/startup-statistics/` (visited on Dec. 15, 2022).

[3] J. Stillman. "New research: Successful people aren't the most talented, just the luckiest." (Mar. 15, 2018), [Online]. Available: `https://www.inc.com/jessica-stillman/successful-people-arent-most-talented-just-luckiest-says-new-research.html` (visited on Dec. 15, 2022).

[4] T. Keelin, P. Schoemaker, and C. Spetzler, *Decision Quality - The Fundamentals of Making Good Decisions*. Decision Quality Foundation, 2008.