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Risk Modelling in Financial Feasibility Study for Caesalpinia sappan Natural Dyes Factory in Surakarta

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Abstract. Emerging concern for sustainability issues in textile industry has increased the interest to use natural dye in the textile wet processing as it offers a solution for a non-polluting waste. One of the popular sources for natural dye is *Caesalpinia sappan* barks. However, the decision to build a factory specializing in producing natural dye powder from *Caesalpinia sappan* would expose several risks and it will need supporting data from a feasibility study especially from the financial aspect that consider the risks. This research aimed to construct a financial model that can be used to identify risk drivers and their impact on the financial result. The risk modelling was conducted using 3-points estimates with Monte Carlo simulation. This research found that the net present value (NPV) is at IDR 1.080.570.007 which is considered as feasible. There are three main risk drivers that have significant impact namely selling price, market share, and material cost. The Monte Carlo simulation from 100 iterations reveals that the mean and median for the NPV is at around IDR 900 million.

1. Introduction

The usage of natural dyes in textile industries has not yet become a popular choice for textile industries due to the effort and cost is considerably higher than those of synthetic coloring process, despite the fact that the waste water of synthetic dyes may damage the environment by contaminating the body of water where it would dispose to [1]. Textile wet processing consume various chemical and high amount of water which produce high amount of waste water containing undesirable chemicals [2]. Using natural dyes in textile wet processing would also consume waters but with less polluting substance due to the natural ingredients used [3]. *Caesalpinia sappan* barks are often used as natural source for red color for textile dyeing for it contains brazilin [1].

In the emerging concern regarding sustainability issues in textile industries, the considerations of using natural dyes start to become an interesting option. Researchers tried to find ways to overcome the drawbacks of natural dyeing such as standardizing color [1,4], improving affinity [2,5], improving rubbing fastness [6]. In preliminary study prior to this research, we surveyed the textile factories in Surakarta region and estimated that their current capacity is at 253 million meters per year and ready to commit 10% of the capacity to natural dyes operations within their factories. Thus, we can safely assume that the market potential for natural dyes product in the region exists including for the dye extracted from *Caesalpinia sappan*.

A feasibility study should be conducted to support the decision to build a factory specializing in producing natural dye extract to responds to the market potential. A feasibility study project may consists of multiple analyses carried out sequentially such as market analysis, technical analysis, economic or financial analysis, and environment analysis [7]. Feasibility studies rely heavily on estimation data starting from the market aspect such as demand prediction up until the financial aspect including cost structure and revenue prediction. Despite being made by experts, the estimations are not free from mistakes and have a high degree of uncertainty [8]. Hence, to ensure the robustness of the decision made, it is crucial for a feasibility study to address the risks which the project is exposed with [9]. Accurate risk management can support mitigation efforts for unexpected events [10].

Many researchers have examined the risk behavior in project feasibility studies. Clarke [11] introduced a simple way to address risk using sensitivity analysis through Monte-Carlo simulation (MCS) using spreadsheet. Martinez et.al. [12] examined how perceived risk including economic, social, time, health, and personal have influence on the entrepreneurial desirability and feasibility which determined whether they want to start a business or not. Better project risk diagnosis and management might help adjust the balance between success and failure [13]. Quantitative risk analysis (QRA) were also done through MCS by Giudice et.al.[8], where they realized that feasibility study may involves multiple and conflicting interests and robustness analysis should help the decision makers become more responsible and transparent.

This research aimed to construct a model to address risks related to the financial aspect feasibility study of a *Caesalpinia sappan*-based natural dye factory project to be built in Surakarta. Surakarta is chosen because we observed many textile factories are located in the city and the minimum wage as per local regulation is considered low. The final product would be a natural dye extract in the form of powder and sold in 1 kg packaging. We investigate the risk drivers and their impact toward the financial results. In doing so, we employed 3-points estimates to vary the parameter values and Monte Carlo simulation to assess the impact.

2. Methods

This research started with the primary and secondary data collection. Primary data gathered from textile factories in Surakarta region to estimate the sales potential for the product. Secondary data gathered from multiple sources to fulfill the financial model requirement such as financing rates, cost of machinery, depreciation policy, tax rate etc. After the data collection, the financial model can be built by modelling the revenue stream and cost stream to construct the forecasted financial reports including profit and loss, balance sheet, and cash flow statement for the 5 years planning horizon. The financial reports are used to assess the financial feasibility based on the Net Present Value (NPV) analysis.

The risk assessment, conducted after the financial model is constructed, is done by identifying the assumption parameters that have significant impact on the model and use the assumptions as risk drivers. The risk drivers are ranked by its impact on the pre-tax profit. Risk modelling is done by creating 3 scenarios i.e. optimistic, most likely, and pessimistic along with the probability of occurrence. To assess the risk impact, a Monte Carlo simulation is conducted for 100 iterations by employing random numbers on each iteration and choose the scenarios matching with the random number. The final step is to analyze the result from Monte Carlo simulation.

3. Financial Model

The financial model is developed as a base for valuation of the feasibility. The financial model was built with the waterfall model approach using a single spreadsheet worksheet. The model includes market potential and revenue projection, capacity planning and project cost, profit and loss statement, balance sheet, cash flow statement, and valuation.

3.1. Assumptions

The financial model requires several assumptions to start with as listed in Table 1.

Table 1. Assumptions

Assumptions	Value	Remarks
Selling Price	500.000	IDR/kg
Caesalpinia sappan price	16.000	IDR/kg
Initial market share	20%	IDR/kg
Wage growth	8,27%	based on average growth in minimum wage
Loan Financing	500.000.000	IDR
Sales Growth	10%	per year
Cost Growth	5%	Estimated from inflation data

3.2. Framework of financial model

The financial model is built based on the framework as illustrated in Figure 1

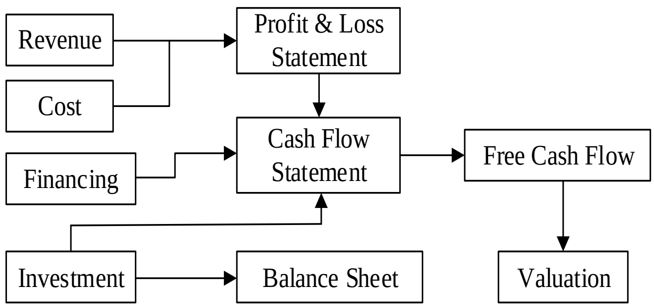

Figure 1. The framework of financial model**.** The model used four inputs i.e. revenue and cost projection, financing plan, and investment plan to construct the 3 financial statements which is required to construct the overall valuation model.

The revenue is measured by multiplying the selling price with the sales quantity for the first year and growing at the pace of the sales growth percentage for the subsequent years. Cost consists of two main components i.e. material cost and wage cost. Investment costs including fixed investment cost (cost for land acquisition, building, and machinery) and venture initiation cost (for intangible assets). The depreciations and amortizations for these investments were also used in constructing the profit and loss statement, but the amount is recaptured during the construction of cash flow statement.

3.3. Free cash flow and valuation

The free cash flow for 5 years planning horizon is shown in Table 2.

Table 2. Free cash flow (IDR)

Year	Pre-Operation	2021	2022	2023	2024	2025
Capital Investment	(1.414.445.779)					
Loan Financing	(500.000.000)					
Cashflow from operation		207.221.326	450.896.553	753.660.119	1.129.146.081	1.593.998.767
Salvage Value						1.104.960.000
Free Cashflow	(1.914.445.779)	207.221.326	450.896.553	753.660.119	1.129.146.081	2.698.958.767

In order to calculate the net present value (NPV), we first calculate the minimum attractive rate of return (MARR) based on the project financing decision which will use combination of personal fund and loan financing. Our MARR also include risk premium as the hurdle rate which made our MARR is at 15,09%. The NPV for this cash flow is IDR 1.080.570.007 which positive value indicating that the project is financially feasible.

4. Risk Model

4.1. Risk driver identification

The risk model started by defining the risk drivers which would have significant impact in our model. We used our initial assumptions as sources for risk drivers and we simulate the impact of changing the parameters to our pre-tax profit, hence, we can identify which risk drivers have the most impact. The results are reported in Table 3.

Table 3. Risk drivers' assessment

Risk drivers	Initial Value	Avg. Pre-tax Profit	5% increase	Avg. Pre-tax Profit after increase	Absolute change	Rank
Selling price	500.000	837.770.115	525.000	968.234.977	15,57%	1
Caesalpinia sappan price	16.000	837.770.115	16.800	805.263.756	3,88%	3
Initial market share	20%	837.770.115	21,00%	933.220.603	11,39%	2
Wage growth	8%	837.770.115	8,69%	829.873.500	0,94%	5
Loan Financing	500.000.000	837.770.115	525.000.000	835.145.115	0,31%	7
Sales Growth	10%	837.770.115	10,50%	858.781.430	2,51%	4
Cost Growth	5%	837.770.115	5,25%	833.141.674	0,55%	6

Based on the absolute change in average pre-tax profit, we found that the top 3 risk drivers are selling price, initial market share, and material cost. These risk drivers will be used in the risk simulation step to measure their impact toward the financial feasibility.

4.2. 3 Points estimates scenario and Monte Carlo simulation

The simulation process requires several scenarios for each risk drivers. In this research, we used 3 points estimates namely most likely, pessimistic and optimistic scenarios. The most likely scenarios values are the same with our initial assumptions. In pessimistic scenarios, we modify the value by changing the values by 25% toward the unwanted condition i.e. lower selling price, lower market share, and higher material cost and we did the opposite in the optimistic scenarios. The probability for each scenario is 40% (most likely), 30% (pessimistic), and 30% (optimistic) and the values are listed in Table 4.

Table 4. 3 points estimates scenarios

Scenario	Pessimist	Most Likely	Optimist
Random number threshold	0,0-0,29	0,3-0,69	0,7-0,99
Selling price	375.000	500.000	625.000
Caesalpinia sappan price	20.000	16.000	12.000
Initial market share	15%	20%	25%

Table 5. Monte Carlo simulation results

#Iterations	100	200
Min	(2.341.132.227)	(2.341.132.227)
Max	5.805.993.421	5.805.993.421
Mean	935.969.162	962.154.244
Median	913.136.476	1.080.570.007
#Negative	40	77
#Positive	60	123

The Monte Carlo simulation is done for 100 iterations and 200 iterations where on each iteration we generate a set of 3 random numbers for each risk drivers. On each iteration, the parameters are changed to match the specific scenario as assigned by the random numbers. For example, if the random number belongs to the first 30 number then the value assigned is the pessimistic scenario value and so on. For each iteration, we calculate the NPV and the results are summarized in Table 5.

5. Discussion

The financial model was built with the waterfall model approach using a single spreadsheet worksheet with intention to reduce the difficulties in conducting the risk simulations because all the formulas were linked to the final result. The financial model is considered valid based on the risk drivers assessment result (Table 3), where we can observe that the value increase in selling price, market share, and sales growth resulting increase in the average pre-tax profit, while increase in material cost, wage, loan, and cost will bring the pre-tax profit average down.

The percentage of change in average pre-tax profit can be used as proxy to assess the importance of each risk drivers to be considered in the model and provide hint on how to manage them. Selling price has the highest impact since 5% increase in the price will create 15% increase in profit which may indicate that maintaining the price level would be a priority when the business operates. The second important factor is initial market share which was set at 20% considering currently not many parties produce natural dye powder in industrial scale. 5% change in market share by 5% will cause 11% change in the pre-tax profit, thus it is important to pursue ways to increase the market share to maximize the profit. The third factor is *Caesalpinia sappan* price which have impact of 3.8% reduction in pre-tax profit when the price is increased by 5%. This material cost was chosen as risk drivers because the cost is 93% of the total production cost. It is implied that securing and maintaining supplier for this material is very important perhaps it should also consider doing backward integration to gain control over the supply.

The 3-points estimates were used as it provides simplicity in modelling risk with discreet probability which will be easier to be understood in general. The 25% value variation was considered sufficient to capture the real condition in the market fluctuation throughout the 5-years planning horizon, a bigger number would mean higher volatility which may indicate higher risk. From the Monte Carlo simulation results we can see that the minimum value occurs when all the random numbers belongs to the pessimistic scenario while the maximum value occurs when all the random numbers belongs to the last 30 numbers. There are 27 different scenario combinations tested in these iterations where we found slightly different mean and median from 100 and 200 iterations. However, from both numbers of iteration, it is observed that 60% of the time the model returns a positive NPV which indicate the project is financially feasible. This finding might indicate that in order to ensure positive NPV, the management should always monitor the risk drivers to avoid being in the unwanted area especially those 3 risk drivers mentioned previously. The mean and median can be used as proxy to calculate the expected return from this model.

6. Conclusion and further research

The research has been able to construct a financial feasibility model which already considered the risk factors exposing the business. Three main risk drivers have been identified namely selling price, market share, and material cost whose impacts found to be significant for the feasibility after conducting the risk simulation. Some managerial implications also have been mentioned and could be used for guidance in mitigating the risks should the project is executed.

This research has several limitations including scope and method which could be improved through further research. The research done was limited for Surakarta city area, so further research ideas can start by expanding the region of marketing and production i.e. Central Java or East Java. The risk modelling can also be further investigated using different method instead of 3-points estimate and Monte Carlo simulation which can only model the discreet event. An investigation will be required should the parameters' values are not naturally discreet.

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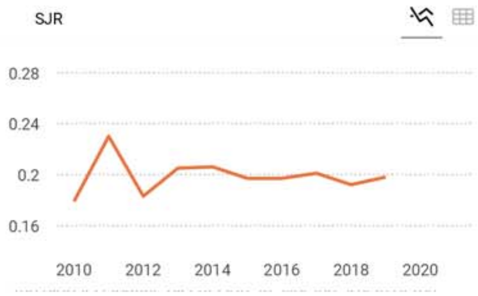

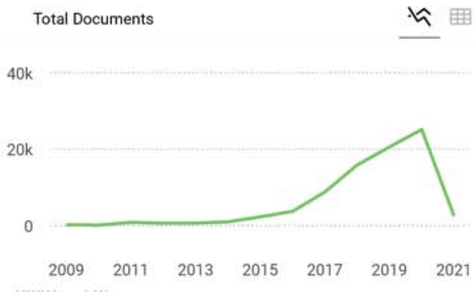

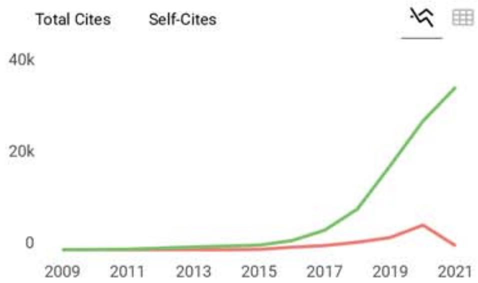

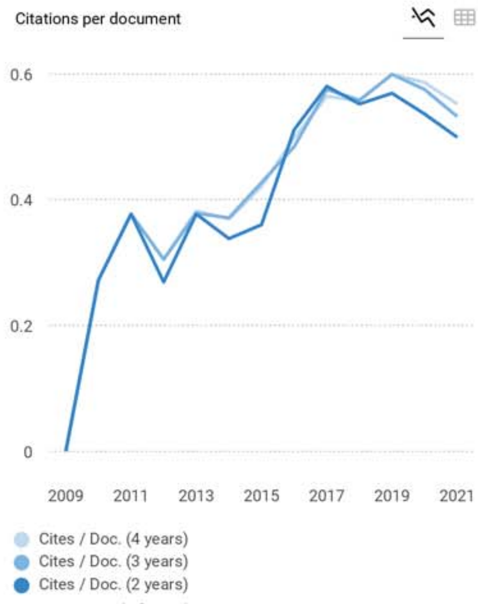

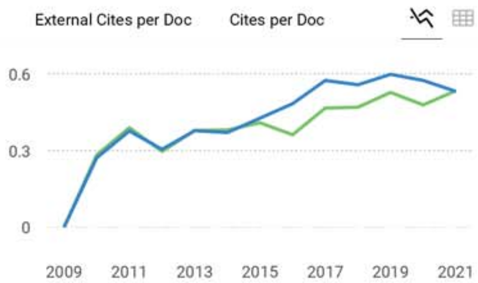

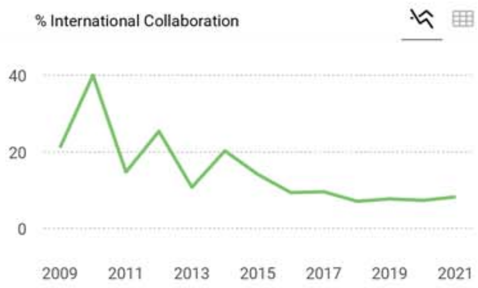

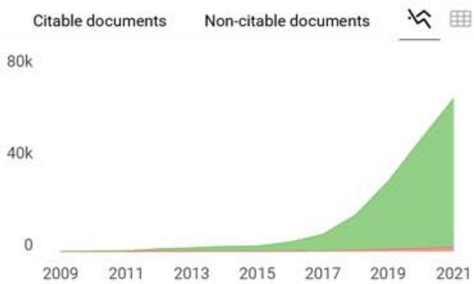

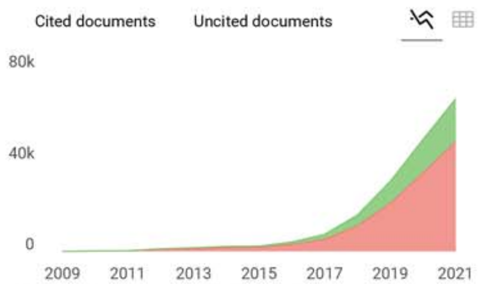

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