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Model of Start-Up Business with Considering Household Spending Using System Dynamics Approach

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Abstract. This study investigates a family-run start-up business where the company's finances are not separate from the family's finances. The start-up business owner relies on the company's finances to cover household spending from the beginning because the company does not pay the owner. As a result, the company fails to grow and is on the verge of bankruptcy. This study focuses on developing a start-up business model that considers household spending as a decision variable allowing it to grow and develop. The System Dynamics approach was chosen due to the complexity of the trade-offs between variables in a start-up business model. A Cassava meatball start-up business run by a Madrasah serves as an example. The proposed model simulates a variety of treatments, including giving debt to establish start-up businesses. However, this debt can be burdensome because the company is required to pay it. The findings indicate that using income to cover household spending at the beginning is inappropriate while providing debt to revive the startup must be sufficient and timely. The proposed model is expected to assist start-up business owners in selecting a variety of alternative policies that will allow the business to grow, develop, and be sustainable.
Keywords: start-up business, system dynamics, household spending

INTRODUCTION

Abrams (2012) defines a start-up business as "a term often used for a young business; most often applied when the business has the intent or potential to grow to a substantial size." The company is still in its early phases and is performing research and development to determine the proper market.

Salamzadeh and Kawamorita (2015) define the business lifecycle as having three major stages: bootstrapping, seeding, and creation. The bootstrapping stage is the early stage in which entrepreneurs turn their ideas into profitable businesses, whereas the seed stage occurs after the prototype hits the market. The creation stage is when the product enters the market, the company generates revenue, and the firm is formed, with corporate

finance serving as the principal funding source. Kim et al. (2018) classified critical success factors for design start-up businesses into four categories: entrepreneurship, innovation, technology, and economics. According to market research in Korea, the most important innovation success factor for start-ups is idea commercialization.

In practice, a family-owned business in a start-up stage makes no distinction between family and corporate finances, making it difficult to keep track of the company's finances. When the entrepreneur does not receive a private payment, corporate finance is commonly used to cover household spending. Ideally, a start-up business in the creation stage should prioritize revenue to expand the market to avoid failing to grow and facing insolvency.

Huang and Kunc (2012) create a generic start-up model to test various policy scenarios and strategies in business development, as well as analyze the causes of failure in a business, particularly in its early stages of operation (Startup). The two issues, i.e. household spending and private payoff must be considered when creating this start-up business model.

Previous researchers have applied System Dynamics to business modeling. Cosenz (2017) demonstrates how System Dynamics modeling can enhance performance management by creating a Dynamic Business Model Canvas (DBMC), combining Business Model Canvas and System Dynamics. Abdelkafi and Täuscher (2015) present a novel perspective on BMfS and use System Dynamics to construct a coherent conceptual model. The proposed model connects four submodels: the firm, the environment, the decision maker, and the customer.

Zali et al. (2014) use System Dynamics to model the dynamic behavior of entrepreneurs and categorize them into two taxonomies based on their level of analysis and modeling. The level of analysis is divided into three categories: micro, meso, and macro, whereas the level of modeling is divided into six steps. The first three are concerned with modeling and the others with finding a better alternative for the system and its implementation.

Previous research has shown that the dynamics of start-up businesses can be modeled using System Dynamics. Hence, this study employs Huang and Kunc's (2012) dynamics model, considering spending and private payoff.

LITERATURE

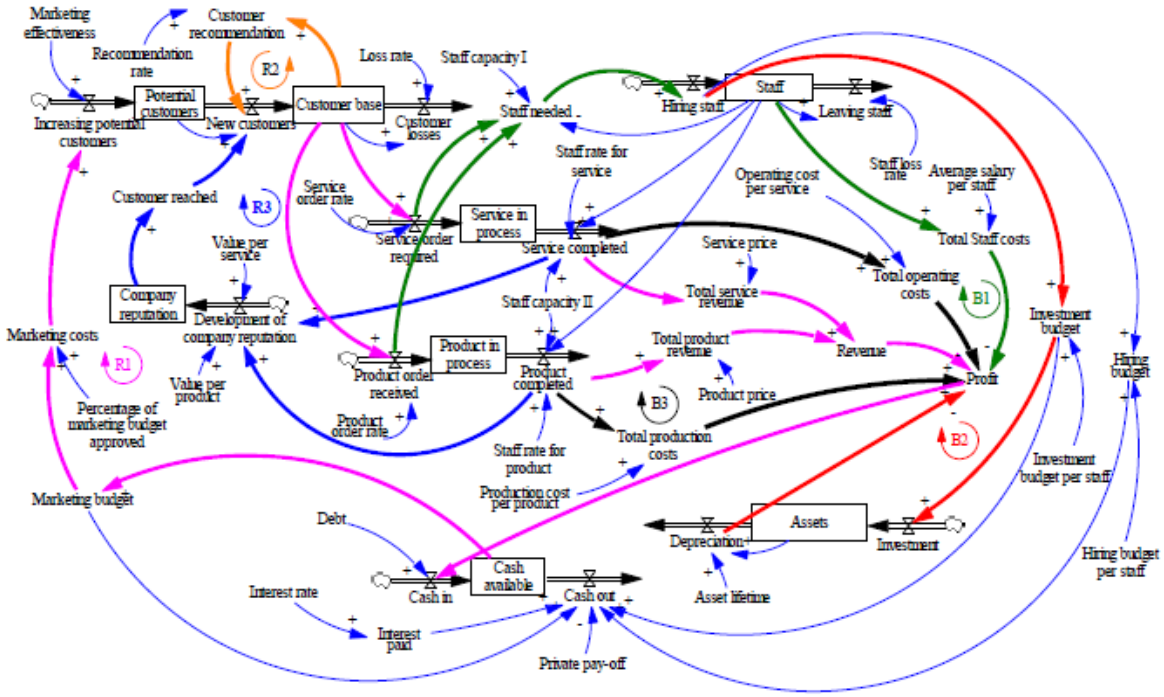
System Dynamics (SD) has emerged as a powerful tool for modeling complex, feedback-driven behaviors in start-up businesses, with applications ranging from financial forecasting to customer dynamics and operational management. Recent research stresses the value of simulation in recreating crucial aspects of start-ups such as funding, hiring, and scaling within start-ups. SD modeling allows start-ups to gain a dynamic view of their growth, assisting founders and investors to comprehend potential future states and make informed, data-driven decisions. SD-based start-up models can estimate customer growth and cash flow, allowing founders to test capital-raising strategies, manage part-time vs. full-time staff, and optimize hiring processes based on expected consumer demand and resource restrictions (Huang and Kunc, 2012).

This study adopts a start-up model proposed by Huang and Kunc (2012) which consists of eight main variables as main sources namely: workers (staff), products offered (product in process), services offered (service in process), cash availability (cash available), assets (assets), regular customers (customer base), potential customers (potential customers), and company reputation (company reputation). Furthermore, financial variables as a support that is very influential in the resilience of a business consists of revenue (revenue), cash in (cash in), cash out (cash out), profit (profit), income from products (total product revenue), revenue from services (total service revenue), total production costs (total production costs), total operating costs (total operating costs), total wages (total staff costs), investment budget (investment budget), marketing budget (marketing budget), and hiring budgets. Figure 1 shows the flow diagram of the generic startup model, which integrates the main sources and key financial variables stated earlier.

METHOD

System Dynamics (SD) is a modeling methodology that uses feedback loops, stocks, and flows to explain how complex systems behave over time. The steps for modeling utilizing the System Dynamics technique in this study are as follows:

1) The problem definition step involves defining the system to be researched.
2) The System Conceptualization step includes creating a causal loop diagram (CLD) to visualize the interactions and relationships among the system's key components.
3) The model formulation step involves explicitly defining stocks and flows.



Source: Huang and Kunc (2012)

Figure 1. Generic model of start-up business

4) The model validation and scenario testing steps to compare the model's behavior to real-world data (present condition) and other scenarios (e.g., best-case, worst-case) to examine how input changes affect outcomes over time.
5) The result interpretation and decision-making steps include interpreting the simulation findings and generating recommendations based on the model insights to aid decision-making.

DISCUSSION

This study uses the Cassava Meatball start-up firm managed by Madrasah Al Binaa in Bandung, Indonesia, as a case study.

Define the system

The first step in dynamic modeling is to define the system by outlining the Cassava Meatball start-up's business processes. The business process represents the overall business chain, from potential customers to product sales. Potential customers are those who become customers due to effective marketing that persuades them to do so. Aside from potential customers, the company's reputation may persuade someone to become a new customer. The number of customers is then estimated by adding the number of old customers who return to purchase products, the number of new customers who arrive from

old customer recommendations (potential customers), the company's reputation, and the number of consumers lost. The total is referred to as the customer base. The size of this customer base is utilized to determine the desired amount of product (production).

In the observed instance, there is no policy for storing finished products (stock of product). Raw materials and supporting materials are required for production activities, as is labor (desired workers) from both existing employees and new hires. The finished product is subsequently sold to generate revenue and profit after payment costs (labor, production, depreciation, debt repayment, and marketing). Income generates cash. The availability of cash (cash availability) is influenced by the use of money, specifically for the next production capital (labor, raw materials, and auxiliary materials), debt repayment (if any), promotions, depreciation, investment in new or repaired equipment, and household spending. Promotional costs are deducted from cash to pursue new customers, increasing customer numbers. It can attract new customers (potential customers), increasing regular customers.

The increasing number of orders that can be fulfilled, together with the high-quality Cassava Meatball products that many buyers prefer, will boost the company's reputation. Conversely, customer losses can reduce the company's reputation.

The Cassava Meatball business provides the owners with a primary source of income to cover household spending. As a result, the income majority generated by this Cassava Meatball business is used to cover household spending initially, with the remaining going toward future production.

The problem is that the company's finances cannot be monitored. The revenue that should have been used to maintain production was discovered to be nonexistent. As a result, the company stopped producing and nearly went bankrupt. The purpose of this study is to assist business owners grow their businesses. A loan is offered as an alternative solution. Predictions of company growth using this loan are modeled using System Dynamics, which considers household spending. The proposed model is expected to encourage business owners to continue operations and assist them manage their businesses.

System Conceptualization

The business process can be described using a Causal Loop Diagram as shown in Figure 2. The start-up business model proposed in this study is based on Huang and Kunc's (2012) generic model. Unlike the Huang and Kunc (2012) model, the proposed model provides financing to cover household spending without a private payoff, while the Huang

and Kunc (2012) model includes a private payoff as compensation for directors or management. This is prevalent in household-scale start-ups that do not clearly compensate managers and instead use income to cover domestic expenses. This study expands on Prasetyaningsih et al.'s (2019) conceptual model of start-ups by adding new variables, parameters, and linkages.

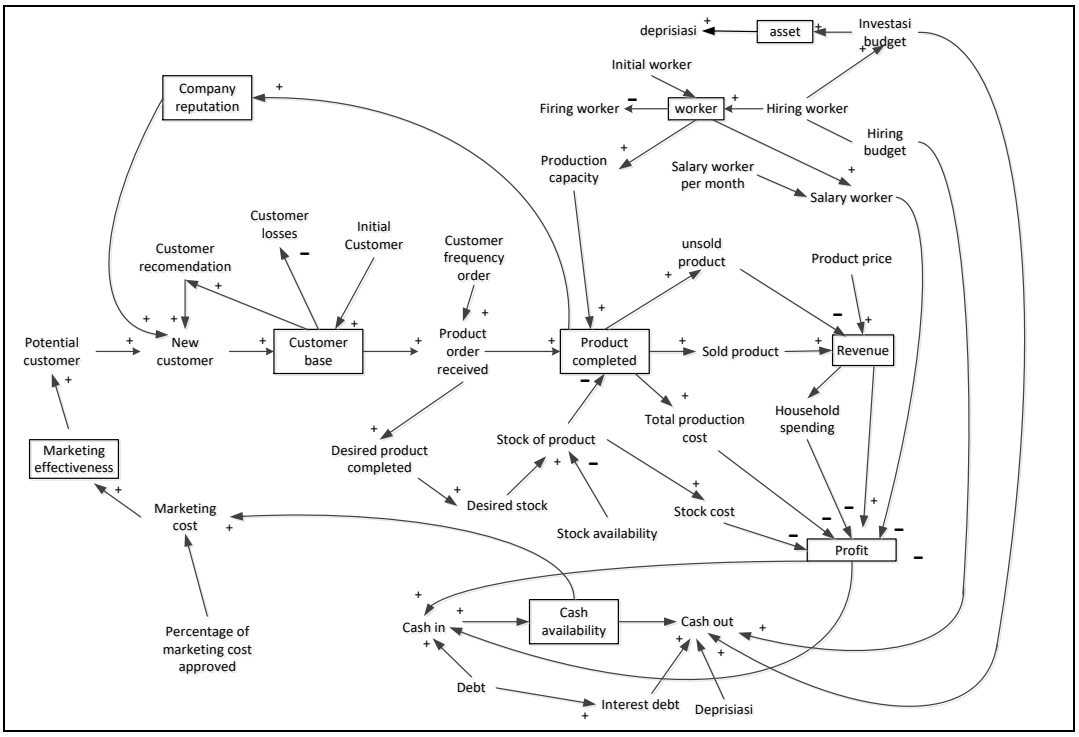


Figure 2. Causal Loop Diagram of Cassava Meatball start-up business

Model Formulation

The model of Huang and Kunc (2012) and Prasetyaningsih et al. (2019) was divided into ten submodels to make it easier to observe. Figures 3 – 13 are sub-models of the structure of the Cassava Meatball Start-up Business concept.

Figure 3 depicts a marketing sub-model in which marketing costs are determined by the amount of funds approved by the entrepreneur.

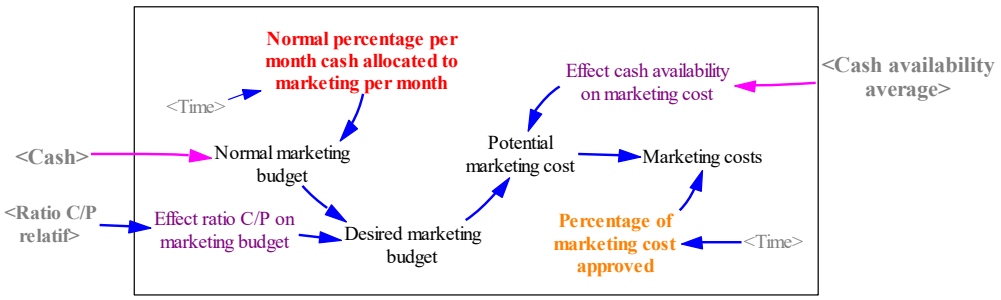


Figure 3. Marketing Sub-Model

Figure 4 depicts the customer sub-model, which explains the customer base as a function of new customers and customer loss. The new customer is the sum of customers acquired due to the company's reputation, potential customers secured through marketing effectiveness, and customer recommendations by existing customers. Marketing effectiveness is influenced by marketing costs as indicated by the marketing sub-model.

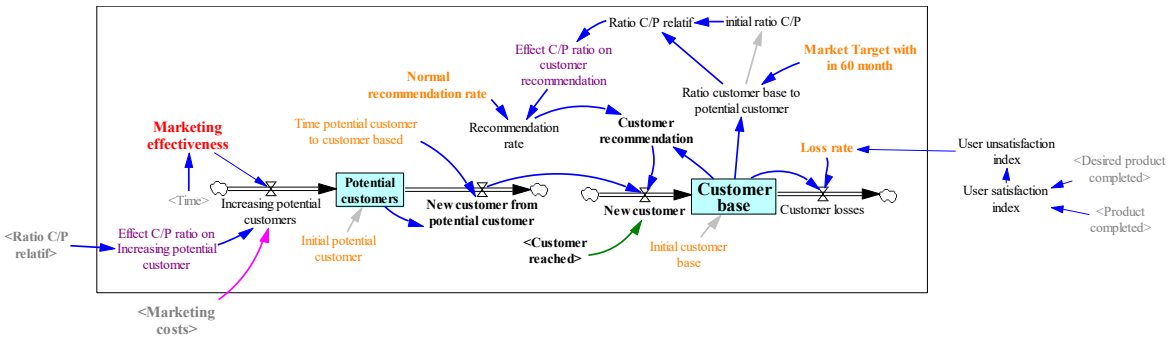


Figure 4. Customer Sub-Model

Figure 5 depicts the production sub-model. The product in the process is constrained by production capacity, which is determined by the total number of workers in the worker sub-model. Product completed is determined by customer orders and non-order production. Figure 6 depicts the worker submodel. Employee dismissal and hiring both have an impact on the total number of employees.

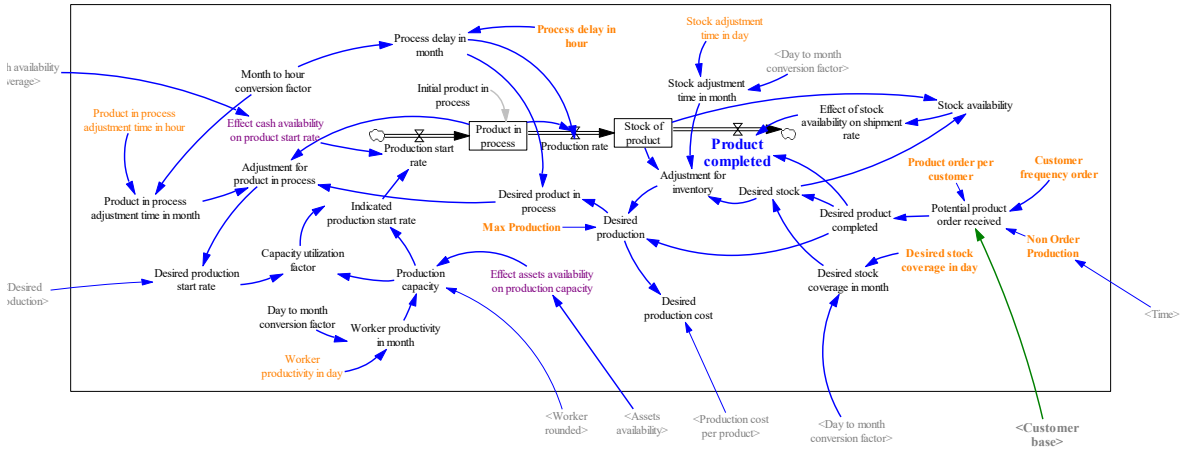


Figure 5. Production Sub-Model

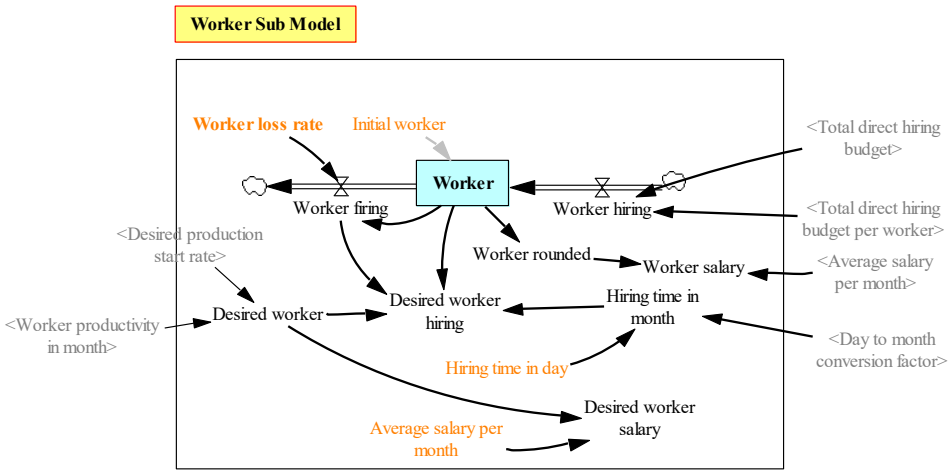


Figure 6. Worker Sub-Model

Figure 7 represents the asset submodel. In this sub-model, assets will be required when employing personnel because training necessitates the use of new equipment. The new equipment represents an investment that will be depreciated. Figure 8 illustrates the household spending sub-model, which is impacted by cash availability and revenue. It means that revenue is prioritized for household spending rather than covering the expense of the following production.

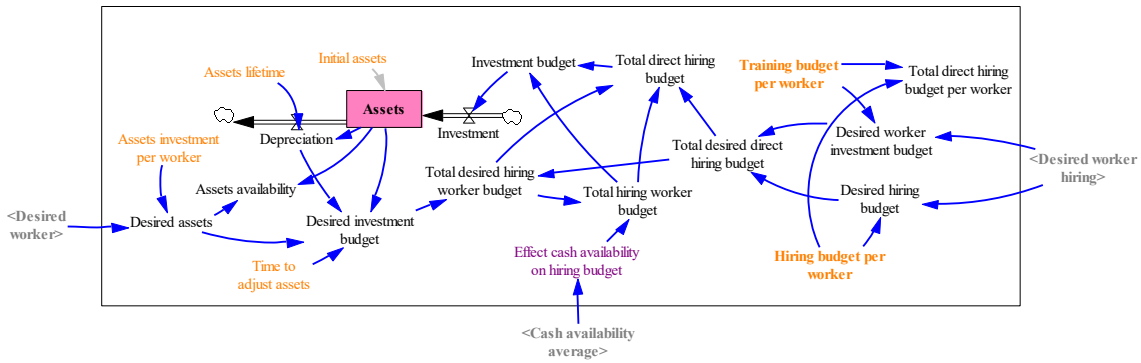


Figure 7. Assets Sub-Model

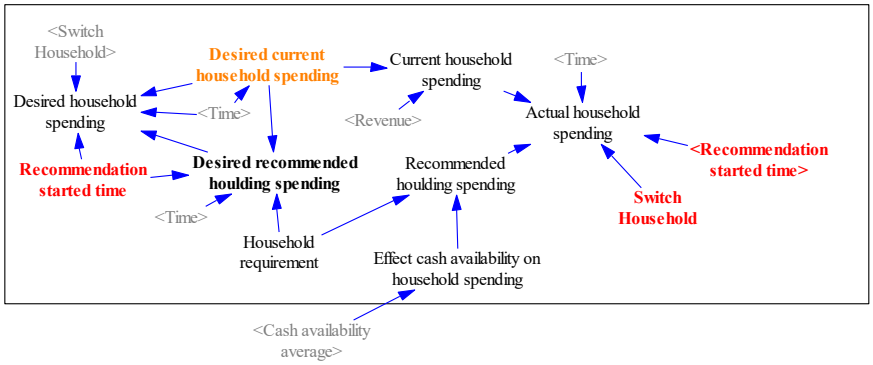


Figure 8. Household Spending Sub-Model

Figure 9 shows the debt sub-model. Prioritizing revenue to meet household spending will result in a deficit, requiring debt to cover future production costs. The quantity of debt allowed is controlled by cash availability, which affects the ability to pay debts. Figure 10 depicts the company reputation sub-model. The amount of product completed will impact the company's reputation. This will boost the number of people willing to buy the product.

Figure 11 represents the cash availability sub-model. Cash availability is impacted by cash and desired cash out to cover production costs, worker salaries, direct hiring budgets, debt repayment, investment budgets, possible marketing costs, interest paid, and household spending.

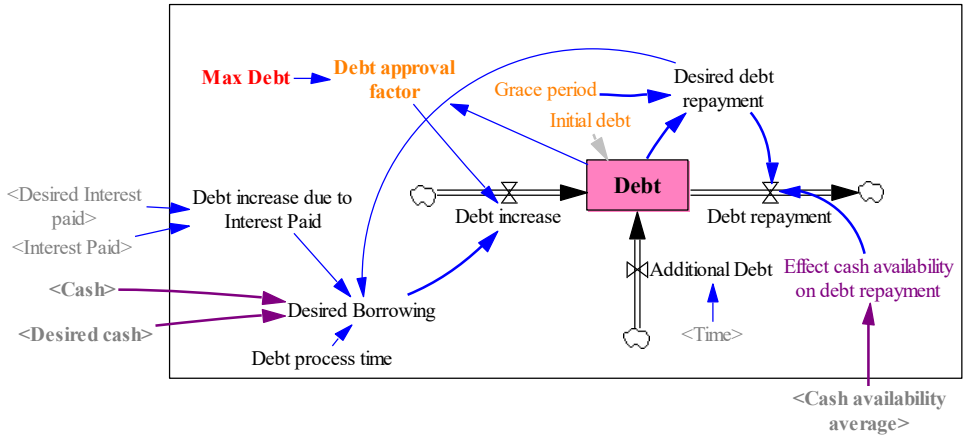


Figure 9. Debt Sub-Model

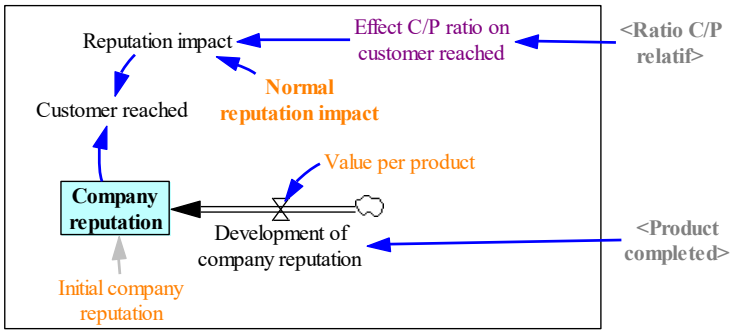


Figure 10. Company Reputation Sub-Model

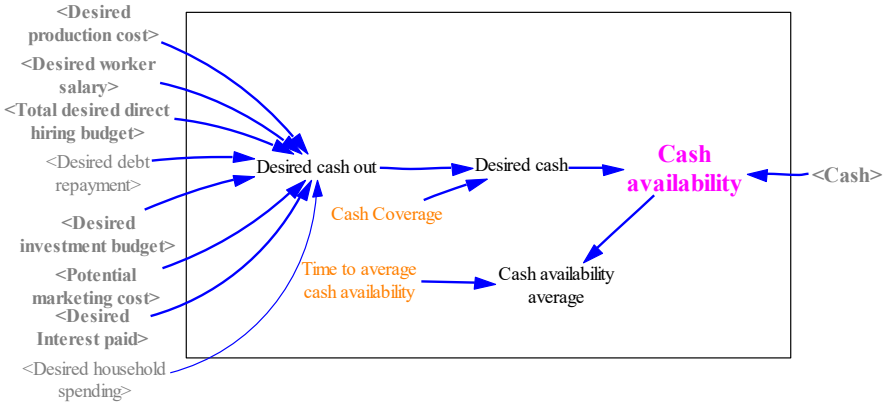


Figure 11. Cash Availability Sub-Model

Figure 12 illustrates the profit sub-model. Profit is calculated using revenue and the overall cost of producing a completed product, including worker salary, depreciation, interest paid, marketing cost, and total direct hiring budget. Figure 13 shows the cash sub-model. Cash represents liquidity. Cash represents the difference between cash in and cash out. Cash in is derived from debt, additional debt, and revenue, whereas cash out is the overall cost borne by the company, which includes production cost, worker salaries, total direct hiring budget, debt repayment, investment budget, marketing costs, and actual household spending.

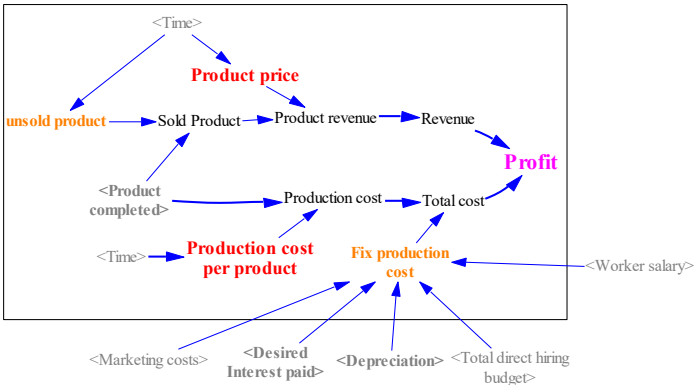


Figure 12 Profit Sub-Model

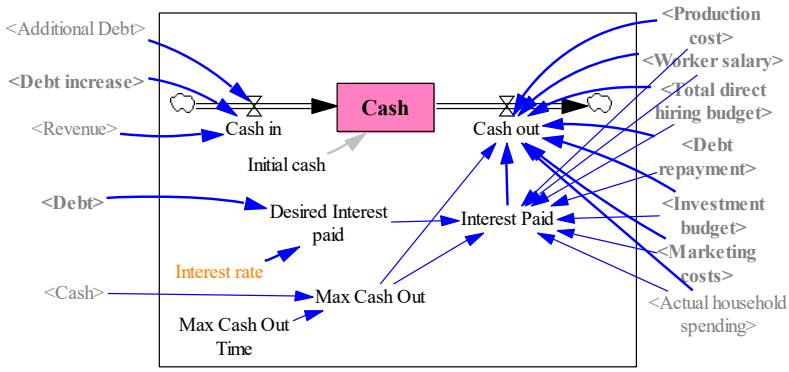


Figure 13. Cash Sub-Model

Model validation and scenario testing

The feasibility of the proposed model is tested using historical data for 12 months of the Cassava Meatball start-up business as follows:

- Assets (stoves, pans, and other production equipment) worth Rp.500,000.
- Initial operational funds of Rp.2,000,000.
- Total production costs Rp.15,000/product to buy raw materials of tuna, cassava, and the supporting materials.
- Selling price: Rp.36,000/product
- The number of initial customers is 10,
- Production capacity of 25 products/workers/day or 500 products/workers/month assuming that the average number of working days is 20 days/month.
- Products sold are around 200 products/month.
- Number of workers is 2 people.
- In the 10th month, the sales employee had an accident, which stopped the marketing. This setback affected the start-up business until the 12th month.

The proposed model is then tested using policy scenarios as seen in Table 1.

Tab1e 1 Scenario for policy analysis

Parameter		Scenario of Simulation				
		Current	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Household spending	Already	Rp.1,500,000 & Rp.5,000,000 at 10th month				
	Recommended		Considering cash	Considering cash	Considering cash	Considering cash
Supported fund	Not available	✓	✓			
	Available			Rp.5,000,000 at 13th month	Rp.9,000,000 at 13th month	Rp.9,000,000 at 15th month
Marketing	Recommended cost		5% of the budget	5% of the budget	5% of the budget	5% of the budget
	Effectiveness		10%	10%	10%	10%

The results of the simulation of 4 policy scenarios and current conditions for each variable are as follows:

a. Product completed

Figure 14 shows the simulation results for the product completed under four scenarios and current conditions.

1) Scenario 1 shows the same behavior as the current condition, indicating the start-up will not alter without additional funding. Even if revenue is no longer used to cover household spending, the start-up's business performance will not improve.
2) Scenario 2 illustrates that granting a debt of Rp.5,000,000 in the 13th month temporarily enhances production, but ultimately falls.
3) Scenario 3 shows that providing debt of Rp.9,000,000 in the 13th month will grow the start-up business again due to the upward trend of production.
4) Scenario 4 shows that providing debt of Rp.9,000,000 in the 15th month will regenerate the start-up business. It can be interpreted that delays in lending will not make Cassava Meatball a healthy venture.

b. Revenue and Profit

Figure 15 depicts profit growth for 4 policy scenarios and current conditions, whereas Figure 16 shows revenue growth. Figures 15 and 16 show that scenario 3 outperforms situations 1, 2, and 4. This suggests that if scenario 3 is implemented, the start-up initiative that has begun to experience losses can recover and is expected to sustain growth.

c. Customer base (loyal customers)

Customer base growth for the 4 policy scenarios and current conditions is shown in Figure 17. Based on Figure 17 it can be concluded that if scenario 3 is implemented the customer base will increase. Meanwhile, in scenarios 1, 2, and 4 and the current conditions, the customer base has the same growth pattern, which increases at first and then decreases after the start-up effort takes several months.

d. Use of revenue for household spending

The usage of funds for household spending under four different scenarios and current conditions is shown in Figure 18. Referring to Figure 18, it can be observed that, taking cash conditions into account, all scenarios advocate halting using funds to meet household spending beginning in the 13th month. Based on scenario 3, the use to satisfy household spending can only commence in month 23.

e. Cash

Figure 19 depicts the cash graph for all four scenarios and current conditions. In the figure, scenario 3 gives an increasingly improving cash condition, even though it drops during the initial stages of restoration. Whereas in other conditions, cash continues to decline.

f. Debt Development

Figure 20 describes a comparison of debt development across four scenarios and current conditions. Figure 20 shows that all possibilities result in a decrease in debt. However, scenario 3 has the best results, with a large debt decrease that is predicted to reach zero (debt paid).

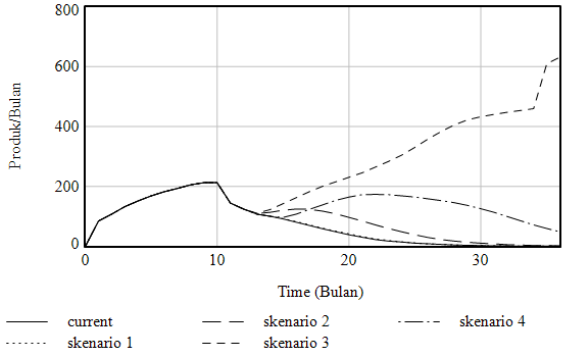


Figure 14. Product Completed Growth

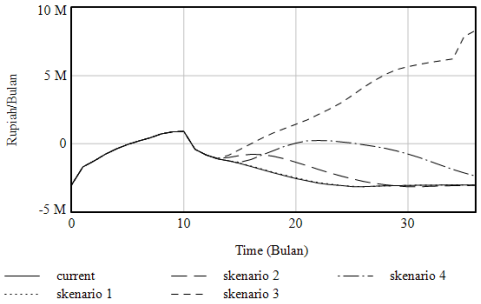


Figure 15. Profit Growth

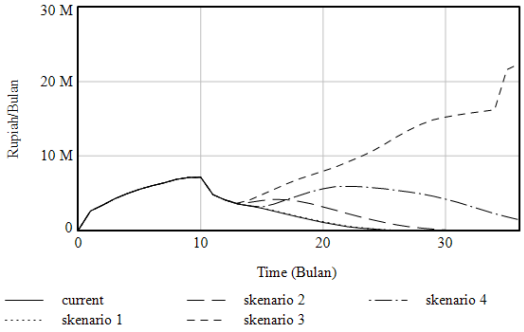


Figure 16. Revenue Growth

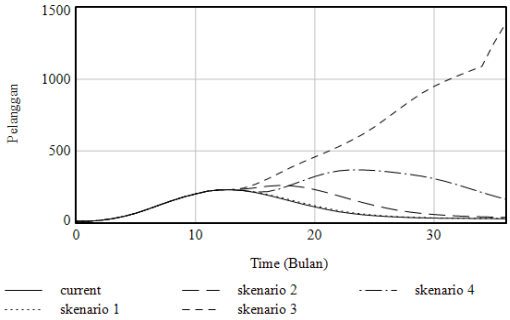


Figure 17. Customer Base Growth

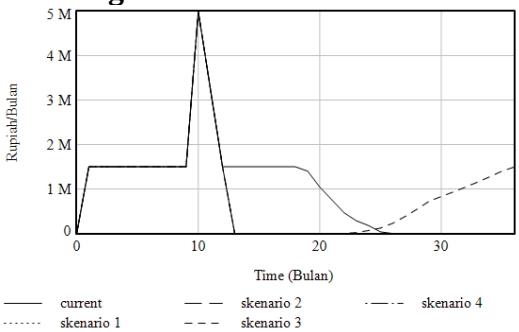


Figure 18. Household Spending

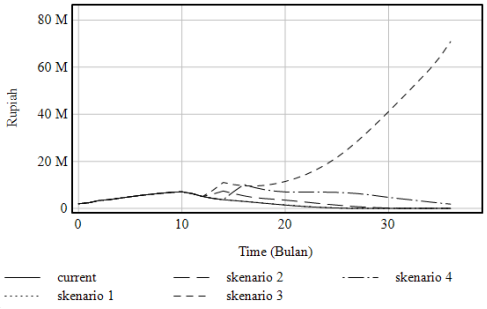


Figure 19. Cash

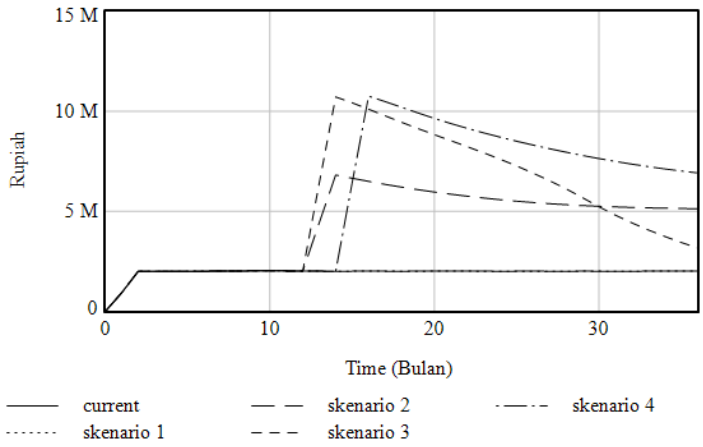


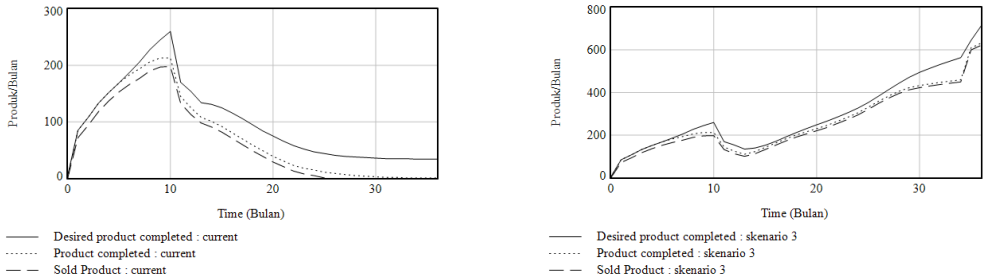
Figure 20. Debt Growth

Recommendations for improvement

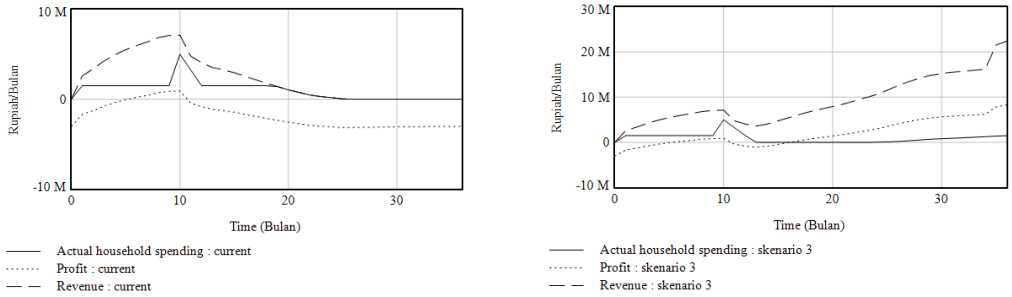
Based on simulations performed using four scenarios and current conditions, scenario 3 produces the best result. Figure 21 (a), (b), (c), and (d) show a comparison of simulation results for present conditions (left) with scenario 3 (right).

Referring to model testing by 4 scenarios and current condition, the recommendations are as follows:

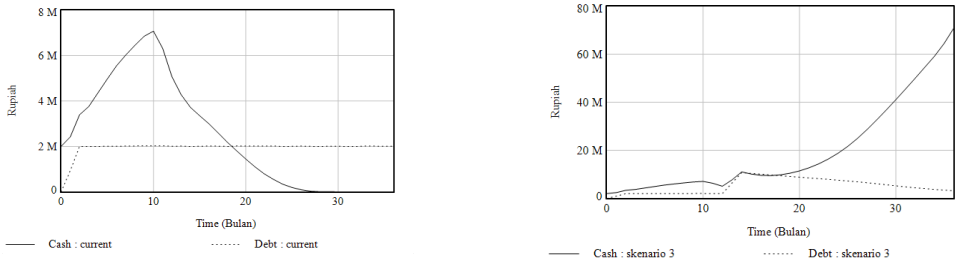
1) Give a debt of Rp. 9,000,000 in the 13th month.
2) Start-up businesses obtain financing from venture capital, grant funds, or Corporate Social Responsibility (CSR) to avoid burdening the government or lenders if they fail to repay it.
3) The usage of cash for household spending is suspended but provides a salary for the manager or owner.
4) Debt funds aim to improve start-up performance.
5) Expansion of marketing through social media platforms like Facebook and Instagram, as well as online marketplaces like TikTok, Shopee, or Tokopedia and others. Marketing costs are used to purchase internet quotas. Furthermore, marketing to packed supermarkets takes the form of free product samples.
6) Company reputation is enhanced by fulfilling customer orders on time or maintaining completed product quality.



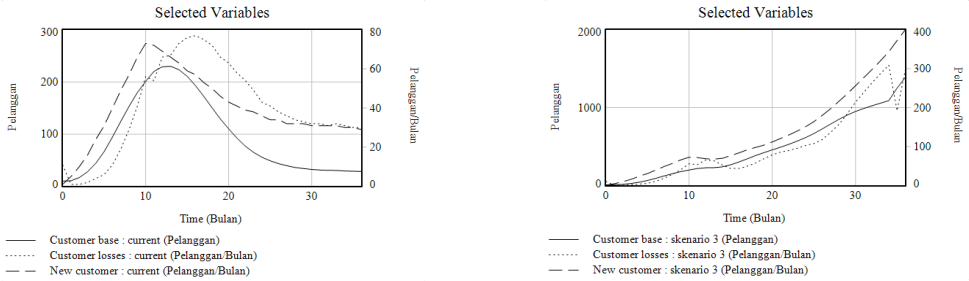
(a) Sold product



(b) Revenue



(c) Cash



(d) New Customer

Current condition Scenario 3

Figure 21 Simulation results of current condition and scenario 3

CONCLUSION

This study demonstrates that startups will grow and develop if funds are prioritized for the continuation of the business rather than for household spending. The minimum available cash must be sufficient to meet business obligations and debt repayment; the remainder can be used to cover household spending. Critical start-ups are in their early

stages of development so all efforts and financial assistance/accompaniment are focused during this time. Too late attempts will be ineffective, even in vain.

In the case taken from this study, the effort to recover the Cassava meatball business to be healthier was done by temporarily stopping the use of income to meet household spending until the company grows and develops. Funding support to revive the start-up must be sufficient and timely, otherwise it will not get any benefits.

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