

Model Multiple Objective Stochastic Programming for Working Capital Management of Micro, Small and Medium Enterprises in Indonesia

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Abstract

Micro, small, and medium enterprises (MSMEs) play a significant role in Indonesia's economy. However, many of these companies face challenges in effectively managing their working capital due to limited financial knowledge and restricted access to credit from banks. The management of working capital is crucial for the success or failure of a company's business activities. To achieve optimal working capital management, company managers must carefully balance profitability and liquidity. This study aims to develop a working capital management model specifically designed for MSMEs in Surabaya City, taking into account the uncertainty of sales and financial limitations. The research examines the relationship between working capital management and business performance, using primary data collected from MSMEs in Surabaya City through area sampling. The analysis employs multiple linear regression to explore the correlation between profitability and liquidity, represented by variables x_1 , x_2 , x_3 , x_4 , and x_5 . Furthermore, a stochastic multi-objective programming approach is utilized to identify an optimal solution considering the uncertain nature of sales. The key variables analyzed include return on assets as a measure of profitability, receivable turnover for liquidity, as well as inventory turnover, accounts payable days, and cash conversion. The findings indicate a positive correlation between accounts payable, inventory turnover, and cash turnover with liquidity. However, both inventory turnover and cash turnover exhibit a negative correlation with profitability.

Keywords: MSME, working capital, stochastic multi objective programming.

1 Introduction

Micro, Small, and Medium Enterprises (MSMEs) play a vital role in the Indonesian economy by contributing to job creation, income distribution, regional economic growth, non-oil and gas exports, and the overall Gross Domestic Product (GDP). However, the MSME sector faces significant challenges in terms of accessing capital, marketing, human resources, and technology. These challenges limit the development of SMEs and make it difficult for their products to compete with innovative foreign counterparts.

In Indonesia, various industries, including small-scale, medium-scale, and large-scale, have emerged. However, not all companies are able to achieve their goals and targets. Effective management across all aspects is crucial for companies to survive in the industry. One aspect of management is working capital management, which refers to the funds used for daily operations. Proper management of working capital is essential to ensure smooth cash flow and optimal company performance. It involves managing the company's current assets and liabilities to achieve the desired levels of profitability and liquidity.

Working capital management has a significant impact on shareholder wealth, firm value, competitiveness, liquidity, and profitability. Companies strive to strike a balance between liquidity and profitability to maximize firm value. The level of working capital directly affects this trade-off, as an aggressive working capital policy can enhance profitability but adversely affect liquidity and risk, while a conservative policy can have the opposite effect. Balancing profitability and liquidity is crucial for the long-term survival of a company, as neglecting either aspect can lead to financial difficulties or bankruptcy.

The objective of this study is to develop a model for determining the optimal working capital structure for manufacturing companies in Indonesia. Given the limited external financial resources and heavy reliance on trade credit in emerging markets, working capital management becomes increasingly important. Inefficient working capital management is a common cause of failure for small companies and start-ups. Therefore, the paper aims to address this issue by developing an efficient working capital structure. The MSME industry in Indonesia holds promising economic prospects.

Data from the Central Bureau of Statistics demonstrates that the number of MSMEs in Indonesia has continued to increase even after the 1997-1998 economic crisis. In 2012, there were 56,539,560 entrepreneurial units in Indonesia, of which 56,534,592 units (99.99%) were categorized as Micro, Small, and Medium Enterprises. The remaining 0.01% (4,968 units) represented large businesses. These figures highlight the potential of the MSME market for financial services, particularly for banks to provide financing. However, a significant portion of MSMEs, around 60-70%, still lack access to bank financing.

2 Literature review

Effective management of working capital is crucial for companies of all sizes as it provides financial flexibility and reduces reliance on external financial sources (Autukaite and Molay, 2011). Small companies, in particular, have a high dependency on their current liabilities for their current assets (Petersen and Rajan, 1997; Arifa and Padachi, 2016). The level of aggressiveness or conservatism in working capital policies varies across industries (Weinraub and Visscher, 1998).

There are several reasons why companies utilize the three components of working capital: receivables, accounts payable, and inventories. Companies offer credit to customers through accounts receivable to manage demand for their products. During periods of low demand, companies can delay collecting payments or extend accounts receivable. Fabbri and Klapper (2016) argue that accounts receivable

serve as a less aggressive and more flexible marketing tool compared to price reductions, which can lead to price wars and competitor reactions. Furthermore, companies provide credit to customers because they have an advantage over banks in offering credit, especially due to their frequent interactions with customers (Petersen and Rajan, 1997).

Accounts payable also serve as a source of financing for companies during liquidity shocks or crises. Additionally, effective inventory management is crucial for working capital. It helps companies avoid excessive or insufficient inventory levels. By controlling inventory, companies can enhance sales by providing flexibility, improving their ability to adapt to changes, and mitigating disruptions in manufacturing due to demand fluctuations. However, maintaining high inventory levels can lead to increased warehousing and inventory costs, potential spoilage and damage, and can conceal inefficiencies in management and poor forecasting (Koumanakos, 2008). Various inventory management techniques such as Material Requirements Planning (MRP) and Just-In-Time (JIT) Systems have been developed to assist companies in making inventory-related decisions.

In this research, we aim to develop a model based on Masri and Abdulla (2017), focusing on start-up retailers. Unlike previous studies, our model utilizes return on assets (ROA) to measure profitability, current assets (CA) to measure liquidity, and factors that are assumed to have a correlation with both variables, such as net working capital (NWC), receivable turnover, inventory turnover, and cash turnover.

3 Research methods

In this study, a multi-objective mathematical model is formulated to determine the optimal working capital. The model aims to achieve two objectives: maximizing profitability and maximizing liquidity. To account for the uncertainty in sales, stochastic programming is employed. Multiple scenarios are considered for each parameter, and the proposed multi-objective mathematical model is transformed into a single objective model using the LP-metric method. Numerical examples are provided to illustrate the effectiveness of the model.

3.1 Problem description and mathematical model

This research focuses on addressing the challenges faced by micro, small, and medium enterprises (MSMEs) in Indonesia, particularly their limited access to finance as indicated by a survey conducted by Pricewaterhousecoopers, which found that 74% of MSMEs in Indonesia lack financial access. This issue is directly related to the working capital of MSMEs. The main objectives of this study are to maximize profitability and liquidity by examining the correlation between these variables and the working capital variables.

3.1.1 Assumptions

- a. This study does not take into account the cost of building as an asset and does not consider long-term debt.
- b. The profitability of a company is influenced by the level of working capital.

c. The liquidity of a company is affected by the level of working capital.

d. By optimizing trade receivables, accounts payable, and inventories, a company can maximize both profitability and liquidity.

e. The liquidity ratio indicates a company's ability to fulfill its short-term obligations. This ratio includes:

Current Ratio

$$1. \quad \text{Turnover} \quad \frac{\text{Current Asset}}{\text{Current Liability}} \times 100\% \quad (1)$$

$$2. \quad \text{Receivable Turnover} \quad \frac{\text{Cost of Goods Sold}}{\text{Average Inventory}} \quad (2)$$

$$3. \quad \text{Cash Turnover} \quad \frac{\text{Credit Sales}}{\text{Average Receivable}} \quad (3)$$

$$4. \quad \text{Net Working Capital Turnover} \quad \frac{\text{Sales}}{\text{Cash}} \quad (4)$$

$$5. \quad \frac{\text{Cash}}{\text{Current Asset} - \text{Current Liability}} \quad (5)$$

g. Profitability ratios are employed to assess a company's capacity to generate profits. Some of the profitability ratios include:

Return on Asset (ROA)

$$\frac{\text{earning after tax}}{\text{total asset}} \times 100\% \quad (6)$$

h. Decision variables:

1. accounts payable (x1) is money owed by the company
2. accounts receivable turnover (x2) is the money obtained from the calculation of receivable turnover
3. inventory turnover (x3) is obtained from the calculation of inventory turnover
4. cash and cash equivalents (x4) and fixed assets (x5) calculated from cash turnover

i. The sales rate (S) is random and follows a normal probability distribution

Therefore, Stochastic Multi Objective Models obtained such

Constraints:

- 1) The debt permitted by Bank Indonesia for MSME businesses is at least 20% of the total financial

$$x_1 < 0,2 D$$

2) Limit of finance (asset of MSME)

$$x_2 + x_3 + x_4 + x_5 = TA$$

3) For net working capital

$$-x_1 + x_2 + x_3 \leq NTC/360 \text{ multiplied by sales (S)}$$

4) The same as in the previous research model (Masri and Abdulla, 2017) that must determine the relationship between each decision variable on liquidity and profitability as measured using the regression model

$$\text{Profitability} = b_{10} + \sum_{i=1}^5 b_{1i}x_i$$

$$\text{Liquidity} = b_{20} + \sum_{i=1}^5 a_{2i}x_i$$

5) So the model is obtained such

$$\begin{aligned} \text{Objective function} \quad & \text{Maximize } b_{10} + \sum_{i=1}^5 b_{1i}x_i \\ & \text{Maximize } b_{20} + \sum_{i=1}^5 a_{2i}x_i \end{aligned} \quad (7)$$

Subject to:

$$x_1 \leq 0,2 D$$

$$x_2 + x_3 + x_4 + x_5 = TA \text{ (50 million rupiahs for micro)}$$

$$-x_1 + x_2 + x_3 \leq NTC/360 \text{ multiplied by sales (S)}$$

$$l_i \leq x_i \leq u_i \text{ where } i = 1, 2, 3, 4, 5$$

Equation (7) represents a multiple objective stochastic program. To solve such a program, it is necessary to apply two transformations: a multiple objective transformation and a stochastic transformation. These transformations will ultimately lead to a certainty equivalent program, as suggested by Ben Abdelaziz (2012).

The multiple objective transformation involves reducing the program to a single-objective model, while the stochastic transformation aims to convert the model into a deterministic equivalent. In the following section, we propose constructing a certainty equivalent program for the multiple objective stochastic programming represented by Equation (7). This will be achieved by introducing additional assumptions that are appropriate for the micro, small, and medium enterprises (MSMEs) in Indonesia.

Since sales are subject to uncertainty, we adopt a limited opportunity approach by estimating the sales level $S \sim$ using a discrete distribution. We denote the different possibilities as w_n , where n ranges from 1 to N . Based on these possibilities, we plan the probabilities associated with each sales level, denoted as $S(w_n)$ for $n = 1, \dots, N$. With the recourse approach, constraint (3) can be reformulated as follows:

$$-x_1 + x_2 + x_3 - y^+(w_n) + y^-(w_n) \leq \text{NTC}/360 \times S(w_n) \quad (8)$$

where $y^+(w_n)$ and $y^-(w_n)$ are resource variables and represent, respectively, the excess and shortage of working capital when scenario n occurs. For a given scenario n , excess liquidity $y^+(w_n)$ represents a missed opportunity for MSMEs to invest a certain amount of money for a very short time at an interest rate $q(w_n)$. The expected loss of opportunities can be defined as follows:

$$Q(x, w) = \sum_{n=1}^N p_n q(w_n) y^+(w_n) \quad (9)$$

Then propose to add the recourse cost (9) to the liquidity objective function as follows (Masri and Abdulla, 2017):

$$\text{Liquidity} = \sum_{i=1}^5 a_{2i} x_i - \sum_{n=1}^N p_n q(w_n) y^+(w_n) \quad (10)$$

The multiple objective transformations are utilized to reduce the multi-objective function presented in Equation (7). Various approaches have been employed in the literature to handle multiple objective functions, including the stochastic objective programming approach introduced by Contini (1968). This approach involves identifying a stochastic target value for the objective function.

In the case of micro, small, and medium enterprises (MSMEs), their objective is to ensure a certain profit margin π from their sales, with a high level of probability. Therefore, the target for the profitability objective function is expressed as $\pi S \sim$. However, achieving these profitability targets for all scenarios is stochastic and unattainable, and MSMEs agree to achieve this target with a probability level of α . The opportunity constraints approach is suitable for modeling the firm's profitability target, as shown in Equation (10):

Please note that Equation (10) is not provided in the given context, and further information or the complete equation is needed to provide a paraphrased version.

$$P(\sum_{i=1}^5 b_{1i} x_i \geq \pi \tilde{S}) \geq \alpha \quad (11)$$

Based on a stochastic goal programming approach and a chance constrained approach, the profitability objective function (Eq. (6)) is transformed into the constraint (Eq. (11)). The resulting certainty equivalent program to the multiple objective stochastic program (Eq. (7)) is as follows:

Objective function:

$$\text{Maximize} \quad b_{20} + \sum_{i=1}^5 b_{2i} x_i - \sum_{n=1}^N p_n q(w_n) y^+(w_n)$$

Subject to:

$$P(\sum_{i=1}^5 b_{1i} x_i \geq \pi \tilde{S}) \geq \alpha$$

$$-x_1 + x_2 + x_3 - y^+(w_n) + y^-(w_n) \leq \text{NTC}/360 \times S(w_n)$$

$$x_1 \leq 0,2 D$$

$$x_2 + x_3 + x_4 + x_5 = TA$$

$$l_i \leq x_i \leq u_i \text{ where } i = 1, 2, 3, 4, 5 \quad (12)$$

4 Numerical Experimentation

To determine the optimal working capital level, we utilize data from micro, small, and medium enterprises (MSMEs) in Surabaya as an example. However, to maintain confidentiality, the reported data in this section have been slightly modified. Furthermore, for simplicity, we focus on three equiprobable states of nature for the sales level ($N = 3$). These states are represented by $S(w1) = 50$ million rupiahs, $S(w2) = 100$ million rupiahs, and $S(w3) = 150$ million rupiahs.

The average sales level, denoted as (μ), is 100 million rupiahs, with a standard deviation σ_S of 50 million. For the micro enterprise, the total assets (TA) amount to 50 million rupiahs, while the debt level (D) is 10 million rupiahs, representing 20 percent of the total assets.

In Table 2, we present the lower limits (li) and upper limits (ui) for the decision variables. These limits determine the range within which the values of the decision variables should fall.

Please note that the specific values for the lower and upper limits of the decision variables are not provided in the given context, and further information or the complete table is needed to provide a more accurate paraphrased version.

Table 1. Limits on the decision variables.

i	1	2	3	4	5
li	4.7	8.7	7.5	0.6	8.5
ui	7.0	11.3	30	5	25

Table 2. Variable Identification

Variable	Measure
Dependent	
Profitability	ROA
Liquidity	CR
Independent	
X_1	Accounts payable
X_2	Receivable turnover
X_3	Inventory turnover
X_4	Cash turnover
X_5	Fixed asset

Table 3. Regression result

Dependent: Profitability

Variable	Standart coefficient	t_{stat}	P-value	Decision
X ₁	1.057	2.647	.014	Significance
X ₂	-.300	-.953	.350	Not significance
X ₃	-1.895	-3.844	.001	Significance
X ₄	-1.650	2.280	.031	Significance
X ₅	.365	.035	.230	Not significance

From the regression result on Table 3, we can see that account payable has a positive correlate to profitability and significance for significance level 5%. But inventory and cash turnover have negative correlate to profitability.

Table 4. Regression Result

Dependent: Liquidity

Variable	Standart coefficient	Pvalue	Decision
X ₁	2.048	.001	Significance
X ₂	-.356	.350	Not significance
X ₃	1.795	.004	Significance
X ₄	1.502	.021	Significance
X ₅	-.365	.230	Not significance

Based on the regression results presented in Tables 3 and 4, it is evident that accounts payable exhibit a positive correlation with profitability and are statistically significant at a significance level of 5%. Conversely, inventory turnover and cash turnover display a negative correlation with profitability. On the other hand, accounts payable, inventory turnover, and cash turnover demonstrate a positive correlation with liquidity.

For the purpose of the analysis, we assign a profit margin (π) of 0.02 and set the probability of achieving the target profit (α) to 0.9. In the retail market, the net trade cycle (NTC) is fixed at 100 days, and the interest rate for short-term investments ($q(w_n)$) is set to 0.05 for all scenarios. Additionally, we define the values of p_n as 0.3, 0.4, and 0.3, which sum up to a total of 1.

Table 5. Scenarios

Scenario	$S(w_n)$	$q(w_n)$	p_n	$y+(w_n)$	$y-(w_n)$
1	50	0,05	0,3	0,3	0,1
2	100	0,1	0,4	0,2	0,2
3	150	0,15	0,3	0,4	0,3

All Scenarios

α	\bar{S}	σ	π	NTC	TA	0,2.D	$\pi\bar{S}$
0,900	100	50	0,2	100	50	10	20

The equation (12) was solved by using Excel Solver on AMD A9-9425 RADEON R5, 5 COMPUTE CORES 2C+3G 3.10 GHz with RAM 4,00 GB and 64-bit operating system. The result show that

Z_1	16,64
Z_2	5,40
Z_3	24,54
Z_4	9,81
Z_5	11,04

Max Z 67,418

The optimal solution obtained from the analysis reveals a profitability level of 98.8 million rupiahs and a liquidity level of 89.0834 million rupiahs, as shown in Table 3. The optimal value for accounts payable is 16.64 million rupiahs. Additionally, the optimal value for accounts receivable is 5.4 million rupiahs, which is a level that stimulates product demand and strengthens the relationship with suppliers.

The higher level of accounts receivable compared to accounts payable suggests that the MSMEs aim to attract customers and smoothen demand, while suppliers are cautious about extending credit due to the lack of prior transaction history. The relatively high level of inventory serves as a safeguard against unexpected disruptions in the production cycle and mitigates the impact of unstable product demand, while also considering the cost implications.

Furthermore, the MSMEs maintain a relatively high level of cash reserves as a precautionary measure against unfavorable liquidity events. This finding aligns with expectations given the high failure rate among MSMEs, especially micro businesses, primarily due to financial and liquidity challenges.

The optimal level of fixed assets is found to be at the lower limit, which is consistent with the findings of Afrifa and Padachi (2016). This observation can be attributed to the short-term nature of most MSMEs' assets, as they primarily focus on fulfilling immediate operational requirements rather than long-term investments.

5 Conclusion

This paper introduces a stochastic multi-objective programming model to optimize the working capital of MSMEs in Indonesia. The model aims to determine the optimal values for both profitability and liquidity. By solving the mathematical model and conducting sensitivity analysis, the analysis results are obtained.

The analysis reveals that accounts payable, inventory turnover, and cash turnover have a positive correlation with liquidity. This indicates that managing these factors effectively can enhance the liquidity position of MSMEs. However, when it comes to profitability, inventory turnover and cash turnover show a negative correlation. This implies that focusing solely on increasing these variables may not necessarily lead to improved profitability.

To further enhance the research, future studies can consider incorporating additional variables to obtain a more comprehensive and optimal solution. By including a wider range of factors, a more robust understanding of the relationship between working capital and business performance can be achieved.

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