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

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Abstract

MSMEs, or micro, small, and medium-sized businesses, are important to Indonesia's economy. However, because they lack sufficient financial understanding and have limited access to bank loans, many of these businesses struggle to manage their working capital. The way a firm manages its working capital determines whether its business operations succeed or fail. Achieving the best working capital management requires managers of the organisation to carefully balance liquidity and profitability. The purpose of this study is to create a working capital management model especially for MSMEs in Surabaya City, accounting for financial constraints and sales volatility. This study investigates the connection between working capital management and company performance utilising primary data gathered through area sampling from MSMEs in Surabaya City. Multiple linear regression is utilised in the analysis to investigate the relationship between liquidity and profitability, as denoted by variables x1, x2, x3, x4, and x5. In addition, a stochastic multi-objective programming method is applied in order to find the best solution taking into account the uncertainty of sales. The primary factors examined are cash conversion, inventory turnover, accounts payable days, and return on assets, which serves as a proxy for profitability. Receivable turnover is also examined for liquidity. The results show that there is a positive relationship between cash turnover and liquidity, inventory turnover, and accounts payable turnover. Nonetheless, turnover of cash and inventory shows a negative relationship with profitability.

Keywords: Stochastic multiobjective programming, working capital, and MSME.

Introduction

Micro, Small, and Medium-Sized Enterprises (MSMEs) are essential to the Indonesian economy because they increase non-oil and gas exports, income distribution, employment generation, and regional economic growth (GDP). On the other hand, the MSME sector has formidable obstacles concerning technology, human resources, marketing, and capital availability. These obstacles hinder the growth of SMEs and make it harder for their goods to compete with cutting-edge imports.

Large-scale, medium-sized, and small-scale industries have all evolved in Indonesia. Still, not every business succeeds in reaching its objectives. Companies must have effective management in all areas if they are to thrive in their sector. Working capital management, or handling the money needed for day-to-day operations, is one facet of management. For optimal business performance and seamless cash flow, working capital management is crucial. In

order to reach the targeted levels of profitability and liquidity, it entails managing the company's existing assets and liabilities.

The value of the company, profitability, liquidity, competitiveness, and shareholder wealth are all significantly impacted by working capital management. To optimise company value, businesses try to find a balance between profitability and liquidity. This trade-off is directly impacted by working capital levels; a cautious working capital policy may have the opposite effect from an aggressive one, which can increase profitability at the expense of risk and liquidity. A company's long-term sustainability depends on its ability to balance profitability and liquidity, as failing to do so might result in problems with money or even insolvency.

The goal of this research is to create a model that would help Indonesian manufacturing enterprises choose the best working capital structure. Working capital management is crucial in emerging countries because of their high reliance on trade credit and restricted access to external financing. Ineffective working capital management is a major contributor to start-ups and small business failure. In order to solve this problem, the study develops an effective working capital structure. There are bright economic futures for Indonesia's MSME sector.

The Central Bureau of Statistics' data shows that even after the economic crisis of 1997–1998 there was a steady rise in the number of MSMEs in Indonesia. Of Indonesia's 56,539,560 entrepreneurial units in 2012, 56,534,592 units (99.99%) fell into the Micro, Small, and Medium Enterprises category. Large firms made up 4,968 units, or 0.01% of the total. These numbers demonstrate the MSME market's potential for financial services, especially bank borrowing. Still, between 60 and 70 percent of MSMEs do not have access to bank finance.

• **Literature review**

For businesses of all sizes, efficient working capital management is essential since it offers financial flexibility and lessens dependency on outside funding sources (Autukaite and Molay, 2011). The current assets of small businesses, in particular, are heavily dependent on their current liabilities (Petersen and Rajan, 1997; Arifa and Padachi, 2016). Different industries have different working capital policy levels of aggressiveness and conservatism (Weinraub and Visscher, 1998).

Companies use receivables, accounts payable, and inventories—the three parts of working capital—for a variety of purposes. To control the demand for their products, businesses use accounts receivable to extend credit to customers. Businesses may postpone payment collection or extend accounts receivable during times of low demand. According to Fabbri and Klapper (2016), accounts receivable

act as a more adaptable and non-aggressive marketing technique than price reductions, which may spark price wars and rival retaliation. Additionally, businesses give credit to clients because they are better at it than banks are, particularly because of how often they deal with clients (Petersen and Rajan, 1997).

Moreover, accounts payable provides funding for businesses in times of crisis or shock to their cash flow. Additionally, working capital depends on efficient inventory management. It assists businesses in avoiding having too much or too little inventory. Businesses can increase sales by managing inventory because it gives them flexibility, makes them more adaptable, and helps to minimise manufacturing delays brought on by shifts in demand. Maintaining high inventory levels, however, can increase the cost of warehousing and inventory, increase the risk of spoiling and damage, and mask management inefficiencies and inaccurate predictions (Koumanakos, 2008). Many inventory management strategies have been

created to help businesses make decisions about inventory, including Just-In-Time (JIT) systems and Material Requirements Planning (MRP).

Our goal in this study is to create a model that is centred on start-up merchants and is based on Masri and Abdulla (2017). In contrast to earlier research, our model makes use of current assets (CA) to gauge liquidity and profitability as well as variables like net working capital (NWC), receivable turnover, inventory turnover, and cash turnover that are thought to be correlated with both variables.

- **Research methods**

To ascertain the ideal working capital, a multi-objective mathematical model is developed in this study. The two goals of the model are to maximise profitability and maximise liquidity. Stochastic programming is used to take the unpredictability in sales into consideration. For every parameter, several scenarios are taken into account, and the LP-metric approach is used to convert the suggested multi-objective mathematical model into a single objective model. The model's efficacy is demonstrated through numerical examples.

An explanation of the issue and a mathematical model

The present study endeavours to tackle the obstacles encountered by micro, small, and medium-sized firms (MSMEs) operating in Indonesia. Specifically, the study highlights the restricted availability of finance, as suggested by a PricewaterhouseCoopers survey revealing that 74% of MSMEs in the country do not have access to it. The working capital of MSMEs is closely tied to this problem. This study's primary goals are to maximise profitability and liquidity by analysing the relationship between these variables and the variables related to working capital.

Presumptions

Both long-term debt and the cost of construction are not taken into consideration in this study.

The amount of working capital in a business affects its profitability.

The amount of working capital a corporation has an impact on its liquidity.

An organisation can optimise profitability and liquidity by managing its inventories, accounts payable, and trade receivables.

The ability of a business to meet its short-term obligations is indicated by the liquidity ratio. This ratio consists of:

Present Ratio

1. Turnover of the Present Asset

The percentage of the total

2. Price of Sold Goods

Average Receivables Turnover Inventory (2) Credit Sales

Average Receivable (3) 3. Turnover in Cash

4. Revenue

Turnover in Cash Net Working Capital (4)

Present Liability − Present Asset (5)

The ability of a business to turn a profit is evaluated using profitability ratios. Among the profitability ratios are the following:

Return on Asset (ROA) $eauing\ afxer\ tax$ x 100% (6)

$aUbal\ asset$

Variables used in decisions:

Money owing by the company's accounts payable (x1) The money derived from the computation of receivable turnover is known as receivable turnover (x2).

The computation of inventory turnover yields the following results: cash and cash equivalents (x4), fixed assets (x5), and inventory turnover (x3).

The normal probability distribution is followed by the random sales rate (S). Stochastic Multi Objective Models as a result produced the following Constraints:

For MSME enterprises, Bank Indonesia allows loan that represents at least 20% of total financial

x1 < 0,2 D

Financial limit (asset of MSME) TA = x2 + x3 + x4 + x5

For net working capital, multiply sales (S) by (x1 + x2 + x3) ≤ NTC/360.

Similar to the earlier study model (Masri and Abdulla, 2017), which required establishing the correlation between every choice variable on profitability and liquidity as determined by the regression model

Revenue = b10 + ∑5 Liquidity = b20 + ∑5
~$b1ixi\ a2ixi$

HA = 1.

Thus, the model has an objective function.Optimise b10 + ∑5.

Optimise b20 + ∑5.

$b1ixi\ b2ixi$

(7)

Assuming: x1 ≤ 0,2 D}$i=1$

TA (50 million rupiahs for micro) = x2 + x3 + x4 + x5 –x1 + x2 + x3 ≤ NTC/360 multiplied by sales (S) li ≤ xi ≤ ui, where i = 1, 2, 3, 4, 5

A stochastic programme with many objectives is represented by equation (7). Two transformations must be applied in order to solve such a programme: a stochastic transformation and a multiple objective transformation. These changes will eventually result in a programme that is similar to certainty, as proposed by Ben Abdelaziz (2012).

While the stochastic transformation seeks to transform the model into a deterministic equivalent, the multiple objective transformation reduces the programme to a single-objective model. We suggest building a confidence comparable programme for the multiple objective stochastic programming shown in

Equation (7) in the section that follows. To do this, more presumptions that are suitable for Indonesia's micro, small, and medium-sized businesses (MSMEs) will be introduced.

We choose a limited opportunity approach, predicting the sales level S∼ using a discrete distribution, because sales are unknown. We represent the various scenarios as wn, where n is a number between 1 and N. We plan the probability associated with each sales level, represented as S(wn) for n = 1,..., N, based on these possibilities. Rephrasing constraint (3) using the recourse approach looks like this:

$-x1 + x2 + x3 - y+(wn) + y-(wn) \leq NTC/360 \times S(wn)$} (8), in which the resource variables y+(wn) and y−(wn) stand for the excess and deficit of working capital, respectively, in the event that scenario n materialises. In a certain situation n, MSMEs would have missed their chance to invest a specific quantity of money for a brief period of time at an interest rate of q(wn) if there was surplus liquidity y+(wn). The following definition applies to the predicted loss of opportunities:

$Q(x,w) = \sum N \{pn \{q(wn)y+(wn) \sim (9)$

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

Liquidity is equal to $\sum 5 \sim a2ixi - \sum N \{pnq(wn)y+(wn)\}$ (10)

Equation (7) presents the multi-objective function that is reduced by the use of multiple objective transformations. The literature has used a variety of techniques to deal with numerous objective functions, such as Contini's stochastic objective programming approach (1968). Finding a stochastic target value for the objective function is the first step in this method.

Micro, small, and medium-sized businesses' (MSMEs') goal is to almost certainly guarantee a specific profit margin (π) from their sales. As a result, πS∼ is the aim for the profitability objective function. Though it is impossible to reach these profitability targets in all cases, MSMEs agree to hit this target with a probability level of α. Equation (10) illustrates that the opportunity constraints technique is appropriate for modelling the firm's profitability aim.

It should be noted that Equation (10) is not supplied in the context that is given, and in order to provide a paraphrased version, more details or the entire equation are required.

Five i=one$\}\{b1ixi \geq \tilde{\pi}S) \geq \alpha$ (11)

The constraint (Eq. (11)) is derived from the profitability objective function (Eq. (6)) using a stochastic goal programming approach and a chance constrained approach. Equation (7) yields the following certainty comparable programme to the multiple objective stochastic programme:

Goal function:

Optimize $b20 + \sum 5 \{b2ixi - \sum N \{pnq(wn)y+(wn)$

Regarding:

$$5 \; i{=}1 \; \{b1ixi \geq \tilde{\pi}S) \geq \alpha$$

$$y{+}(wn) + y{-}(wn) - x1 + x2 + x3 \leq NTC/360 \times S(wn)$$

Where i = 1, 2, 3, 4, 5; x1 ≤ 0,2 D x2 + x3 + x4 + x5 = TA li ≤ xi ≤ ui

• **Numerical Experimentation**

We use data from micro, small, and medium-sized companies (MSMEs) in Surabaya as an example to calculate the ideal working capital level. However, the reported data in this section have been somewhat altered to ensure confidentiality. Moreover, we concentrate on three equiprobable states of nature for the sales level (N = 3) in order to keep things simple. S(w1) = 50 million rupiahs, S(w2) = 100 million rupiahs, and S(w3) = 150 million rupiahs represent these states.

The standard deviation, σS, is 50 million rupiahs, and the average sales level, represented as (mu), is 100 million. The micro enterprise's debt level (D) is 10 million rupiahs, or 20 percent of its total assets, whereas its total assets (TA) are 50 million rupiahs.

Table 2 displays the choice variables' lower and upper bounds, respectively. The range that the values of the choice variables should lie inside is established by these restrictions.

Please take note that the offered context does not include the precise values for the lower and upper bounds of the choice variables; more data or the full table are required to provide a more accurate paraphrase.**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(wn)) is set to 0.05 for all scenarios. Additionally, we define the values of pn 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	S	σ	π	NTC	TA	0,2.D	πS
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**

As indicated in Table 3, the analysis's ideal solution indicates a profitability level of 98.8 million rupiahs and a liquidity level of 89.0834 million rupiahs. For accounts payable, 16.64 million rupiahs is the ideal amount. Furthermore, 5.4 million rupiahs is the ideal value for accounts receivable; this

amount increases demand for the goods and improves ties with suppliers.

Due to their lack of previous transaction history, suppliers are hesitant to give credit to MSMEs, which may be shown by the larger amount of accounts receivable compared to accounts payable. MSMEs also seem to be trying to acquire clients and calm demand. In light of the potential costs, the relatively high level of inventory reduces the effects of fluctuating product demand and acts as a buffer against unforeseen interruptions in the production cycle.

Additionally, the MSMEs keep a sizable amount of cash reserves on hand as insurance against adverse liquidity occurrences. This result is in line with predictions considering the high failure rate of MSMEs, particularly micro firms, which is mostly caused by cash flow and financial difficulties.

The lower limit is shown to represent the ideal level of fixed assets, which is in line with Afrifa and Padachi's (2016) conclusions. The aforementioned observation can be explained by the transient character of the majority of MSMEs' assets, as they prioritise meeting short-term operating needs above making long-term investments.

Conclusion

A stochastic multi-objective programming model is presented in this paper to optimise the working capital of MSMEs in Indonesia. The goal of the model is to identify the ideal values for liquidity and profitability. The analysis results are acquired by solving the mathematical model and doing sensitivity analysis.

According to the data, there is a positive association between liquidity and accounts payable, inventory turnover, and cash turnover. This suggests that MSMEs' liquidity status can be improved by efficiently controlling these elements. Nonetheless, there is a negative association between cash and inventory turnover and profitability. This suggests that concentrating only on raising these factors could not result in higher profitability.

Future research endeavours may contemplate the integration of supplementary variables in order to get a more exhaustive and ideal outcome, hence augmenting the current study. A more comprehensive knowledge of the connection between working capital and business success can be attained by taking a broader range of factors into account.

References

Citations B. Abuzayed (2012). Jordan as a case study for working capital management and enterprises' performance in emerging markets. 155–179 in Int. J. Manag. Financ. 8 (2).

Padachi, K., and Afrifa, G. (2016). The profitability of SMEs is influenced by working capital level. 23 (1), 44–63; J. Small Bus. Enterp. Dev. Aktas, N., Petmezas, D., and Croci, E. (2015). Does managing working capital add value? proof derived from investments and company performance. Finan. J. Corp. 30, 98–113.

Almazari, A. (2013). Evidence from Saudi cement companies regarding the relationship between working capital management and profitability. Trade Economics and Management, Br. J., 4 (1), 146–157.

Molay, E., and R. Autukaite. 2011. French data on cash holdings, working capital, and corporate value. In: French Finance Association International Conference (AFFI).

Baños-Caballero, S., Martínez-Solano, P., and García-Teruel, P.J. (2012). What impact does working capital management have on Spanish SMEs' profitability? 39 (2) Small Bus. Econ., 517–529.

In 2014, Martínez-Solano, P., García-Teruel, P.J., and Baños-Caballero, S. Financial limitations, company performance, and working capital

management. 332–338 in J. Bus. Res. 67 (3).

F. Ben Abdelaziz. (2012). Multiobjective stochastic programming solution techniques. BMI Research, 2016. Eur. J. Oper. Res. 216 (1), 1-16. Bahraini Retail Industry Report.

Research BMI Fitch Company, United Kingdom. In 2005, Braun, M. and Larrain, B. Evidence from across industries and countries about finance and the business cycle. Financial Journal 60 (3), 1097–1128.

Cooper, W.W., and Charnes, A. (1963). Equivalents that are deterministic for satisficing and optimising under chance restrictions. 11 (1), Oper. Res., 18–39.

2014 Cluttons. Outlook for the Commercial Market in Bahrain.

Cluttons Ltd. B. Contini, 1968. A random method for goal-programming. 16(3), 576–586; Oper. Res.

Madansky, A., and Dantzig, G.B. (1961). About solving two-stage linear programmes in the presence of uncertainty. In: Berkeley Symposium on Mathematical Statistics and Probability, Fourth Edition. Vol. 1. Berkeley, CA: University of California Press, pp. 165–176.

In 1982, De, P.K., Acharya, D., and Sahu, K.C. A goal programming model for capital budgeting with chance constraints. 33 (7) J. Oper. Res. Soc. 635–638.

In 2003, Deloof, M. Does the profitability of Belgian companies depend on their working capital management? 30, 573–587; J. Bus. Financ. Account.

A.M. Eljelly, 2004. An empirical research into the trade-off between liquidity and profitability in an emerging economy. J. Commer. Manag. Int. 14(2), 48–61.

In 2016, Fabbri, D. and Klapper, L. Trade credit and negotiating strength. Finan. J. Corp. 41, 66–80.

In 1993, Fazzari, S.M. and Petersen, B.C. New data on financing constraints: working capital and fixed investments. J. Econ. RAND, 328–342.

Ferris J. (1981). a trade credit utilisation transactions hypothesis. Econ. Q. J. 243–270. Li, K., Harford, J., and Gao, H. (2013). Private companies' perspectives on the factors that influence corporate cash policies.

Financial Econ. J. 109 (3), 623–639.

Martinez-Solano, P. and P. García-Teruel. 2007. working capital management's effects on the profitability of SMEs. 164–177 in Int. J. Manag. Financ. 3 (2).

Burkart, M., Giannetti, M., and Ellingsen, T. (2011). Are you lending what you sell? describing contracts for trade credit. Financial Studies Review, 24 (4), 1261–1298.

Van de Gucht, L.M. and Huyghebaert, N. (2007). New perspectives from business startups on the factors influencing financial structure. 13 (1) Eur. Financ. Manag., 101–133.

Ramadan, I.Z., and Kaddumi, T.A. (2012). The Jordanian example of profitability and working capital management. 4(4), 217; Int. J. Econ. Financ.

Martin, J.D., and A.J. Keown, 1977. A goal programming model for managing working capital that is bound by chance. 22 (3) Eng. Econ., 153–174.

Kim, C.S., Sherman, A.E., and Mauer, D.C. 1998. Theory and facts about corporate liquidity drivers. 33 (3) J. Financ. Quant. Anal., 335-359.

D. Koumanakos. (2008). The impact of inventory control on business operations. International Journal of Product Performance Management, 57 (5), 355–369.

Tryfonidis, D. and Lazaridis, I. (2006). Working capital management and listed companies' profitability on the Athens Stock

Exchange are related. 19 (1) J. Financ. Manag. Anal., 26–35.

Lazaridis, Y., and K. Lyroudi (2000). The Greek food industry's cash conversion cycle and liquidity analysis. In: University of Macedonia Working Paper.

In 2015, Masmoudi, M. and Abdelaziz, F.B. A recourse strategy for the portfolio selection problem bound by chance. Oper. Res. Ann. 1–12.

Ben Abdelaziz, F., and Masri, H. (2010). Have faith in linear programming. Approx. Reason. Int. J. 51 (8), 973–983. Padachi, K. (2006). An examination of working capital management trends and their effects on the performance of Mauritius's small manufacturing enterprises. 2 (2), 45–58; Int. Rev. Bus. Res. Pap.

Abdulla, Y., and Masri, H. 2017. A stochastic programming approach with various objectives for managing working capital. Social Change & Technological Forecasting, 05 (006), 1-6.

M.A. Petersen and R.G. Rajan, 1997. Trade credit: arguments and proof. Ten (3) of Rev. Financ. Stud., 661–691.

In 2015, Rehman, M.Z., Khan, M.N., and Khokhar, I. Examining the relationship between liquidity and profitability using data from Saudi stock exchange (Tadawul) listed companies. Journal of Applied Finance Bank, 5 (3), 159–173.

In 1998, Shin, H. and Soenen, L. Profitability of the company and the effectiveness of working capital management. Finance Practice and Education 8 (2), 37–45.

Smith, K. (1980). Working capital management involves trade-offs between liquidity and profitability. Readings on the Management of Working Capital, ed. K.V. Smith. St. Paul, MN: West Publishing Company, pp. 549–562.

Wilson, N. and Summers, B. (2000). An empirical investigation on the relationship between trade credit management and factoring decisions. Vahid, T.K., Mohsen, A.K., and Mohammadreza, E. (2012). J. Bus. Financ. Account. 27 (1–2), 37–68. Iranian enterprises provide data regarding the effects of working capital management policies on a

firm's profitability and worth. J. Finance Econ. Int. Res. 88, 155–162.

H.J. Weinraub and S. Visscher (1998). Adopting aggressive and conservative working capital policies is an industry practice. Decisions in Finance and Strategy, 11 (2), 11–18.

B. Wilner, 2000. In times of financial hardship, relationships are exploited: the example of trade credit. Journal of Finance 55, 153–178.

Q. Zhang, X. Huang, and C. Zhang. (2015). A mean-risk index model for capital budgeting under uncertain conditions. 761–770 in J. Oper. Res. Soc. 66 (5).