

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

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ABSTRACT

Micro, small and medium enterprises (MSME) have a big influence for the economy in Indonesia. But almost of this company don't have an optimal working capital management because less knowledge and limitation of financial not only from the owner but also financial credit from bank. Working capital management plays an important role in the success or failure of a company its business activities. To achieve optimal use of working capital management managers the company must accurately control the trade-off between profitability and liquidity. The purpose of this research is to develop a model of working capital management where the sales are under uncertainty and the company has a limit financial. This study was tested using multiple linear regression analysis to see the correlation between profitability and liquidity with x_1 , x_2 , x_3 , x_4 , and x_5 then find optimal solution by stochastic multi objective programming because we consider that sales is in under certainty. The main variables used in the analysis of return on assets to measure profitability, receivable turnover to measure liquidity, inventory turnover, accounts payable days, cash conversion. The results showed that account payable, inventory turnover, and cash turn over have a positive correlation for liquidity but inventory turnover and cash turnover have negative correlation to profitability.

Keyword: MSME, working capital, stochastic multi objective programming



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1. Introduction

In the Indonesian economy, Micro, Small and Medium Enterprises (MSMEs) have an important role, even during the turmoil of the economic crisis, MSMEs can make a major contribution in absorbing labor, distribution of income to all regions so that the economic center is no longer depend on one point, increase non-oil and gas exports, and can increase the Gross Domestic Product [1]. The MSME sector has several major challenges that must be faced. Access to capital, marketing, human resources, and technology is a classic problem that is still a limitation in development of SMEs. This classic problem makes SME's products difficult to obtain compete with more innovative foreign products [2-5]. Today, new industries are often found in Indonesia, small (micro), medium and large-scale industries. In its journey, not all companies are able to

achieve the goals and targets that have been set. Companies should have a good management of all aspects in order to survive in the industry [6-9]. One of this management is working capital management. Working capital is the funds that used to pay the company's daily operations. If the working capital owned by the company is not managed properly it will result in difficult funds to circulate so that it is unable to provide optimal results for the company. Working capital management is the management of the components of the company's current assets and current liabilities. The goal is to obtain optimal working capital and be able to support the company in its operational activities so that it can achieve the targeted level of profitability and liquidity [10-15].

Working capital influences shareholder wealth, firm value, competitiveness, liquidity and profitability [16-20]. Therefore, companies usually aim to have well-managed working capital as any change in working capital levels can be critical. The research argues that managers face a trade-off between liquidity and profitability because they seek to maximize firm value. The level of working capital is directly related to the trade-off as an aggressive (conservative) working capital policy has a positive (negative) impact on profitability but a negative (positive) impact on liquidity and risk. If a company ignores its profitability, it cannot survive in the long term, but on the other hand, if it ignores liquidity, it may face bankruptcy problems [21-26]. The research notes that Saudi cement companies face trade-off problems between liquidity and profitability and recommend the development of a more efficient working capital structure. Therefore, companies need to operate optimal working capital levels that maximize both objectives, namely liquidity and profitability [27-32].

The purpose of this paper is to develop a model to determine the optimal working capital structure for manufacturing companies in Indonesia. The importance of working capital management is increasing for companies in emerging markets because of their limited external financial resources and their heavy dependence on trade credit. Inefficient working capital is a cause of failure in small companies and start-ups [33]. The economic prospects show that the MSME industry is one of the most promising business in Indonesian. Data from the Central Bureau of Statistics shows, after the economic crisis 1997-1998 the number of MSME did not decrease, instead it continued to increase, even able to absorb 85 million to 107 million workers in 2012. In that year, the number of entrepreneurs in Indonesia was 56,539,560 units. Of these, Micro, Small and Medium Enterprises (MSME) as many as 56,534,592 units or 99.99%. The rest, about 0.01% or 4,968 units is a big business. The data proves, UMKM is a very potential market for the financial services industry, especially banks to channel financing. Because about 60 - 70% MSME do not yet have access to bank financing [34-37].

2. METHODS

This research develops a multi-objective mathematical model for the problem of get the optimal working capital. We have two objective functions, maximize profitability; and maximize liquidity. Stochastic programming is used to deal with the sales that under uncertainty, scenarios are considered for each parameter and to solve the proposed multi-objective mathematical model as a single objective model with the LP-metric method. Then, numerical examples are given to demonstrate the effectiveness model [38].

2.1 Problem description and mathematical model

In this study, the problem of micro, small, and medium enterprise (MSME) in Indonesia is considered where the results of a survey conducted by Price water house coopers, in which 74% of MSMEs in Indonesia do not have access to finance. So, it has a correlation with working capital of MSME. The objective functions of this study to maximize profitability and liquidity based on correlation between both variables with working capital variables.

Assumptions

- a. This research not considering the building cost as asset and not considering the long-term debt
- b. The level of working capital affects profitability
- c. The level of working capital affects liquidity
- d. The optimal level of trade receivables, accounts payable, and inventories can maximize the company's profitability and liquidity
- e. The liquidity ratio shows the ability of a company to meet its short-term obligations. This ratio consists of:

1. Current Ratio

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

- f. Activity ratio shows how fast the elements of assets turn into sales or cash. Therefore, this ratio is used to measure a company's effectiveness in managing its assets. Activity ratios include:

2. Inventory Turnover

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

3. Receivable Turnover

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

4. Cash Turnover

$$\frac{\text{Sales}}{\text{Cash}} \quad (4)$$

5. Net Working Capital Turnover

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

- g. Profitability ratios are used to measure a company's ability to generate profits. Included in the profitability ratios include:

6. Return on Asset (ROA)

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

- h. Decision variables:
1. accounts payable (x_1) is money owed by the company
 2. accounts receivable turnover (x_2) is the money obtained from the calculation of receivable turnover
 3. inventory turnover (x_3) is obtained from the calculation of inventory turnover
 4. cash and cash equivalents (x_4) and fixed assets (x_5) 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

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

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

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

5. So, the model is obtained such

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

Subject to:

$$x_1 \leq 0,2 D \quad (8)$$

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

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

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

Equation (7) is a multiple objective stochastic program. A solution strategy for a multiple objective stochastic program should be based on two transformations, a multiple objective transformation and a stochastic transformation, that will lead to a certainty equivalent program (Ben Abdelaziz, 2012). In the multiple objective transformation, the program is reduced to a uni-objective model and in the stochastic transformation, the model is transformed into a deterministic equivalent. In the next section, we propose to build a certainty equivalent program for the multiple objective stochastic programming (Eq. (7)) based on additional hypotheses appropriately defined by the MSMEs in Indonesia.

Because sales are stochastic (uncertain), a transformation is carried out with a limited opportunity approach, first estimating the sales level $S \sim$ with a discrete distribution and denoting it as $w_n, n = 1, \dots, N$ possibilities and planning the probability of the sales level $S(w_n), n = 1, \dots, N$. Under the recourse approach, constraint (3) can be rewritten as follows:

$$-x_1 + x_2 + x_3 - y + (w_n) + y - (w_N n) \leq \frac{NTC}{360} \times S(w_n) \quad (9)$$

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:

$$Q(x, w) = \sum_{n=1}^N p_n q(w_n) y^+(w_n) \quad (10)$$

Then propose to add the recourse cost (9) to the liquidity objective function as:

$$\text{Liquidity} = \sum_{i=1}^5 a_{2i} x_i - \sum_{n=1}^N p_n q(w_n) y^+(w_n) \quad (11)$$

Multiple objective transformations aim to reduce multi objective function in Equation (8). In the literature, many objective functions have been handled using several approaches, including the stochastic objective programming approach, where the stochastic target value is identified for the objective function. In this context, MSMEs aim to guarantee, up to high-level probability, a certain profit margin π from the company's sales. Therefore, the target for the objective function of profitability is equal to $\pi S \sim$. Profitability targets are stochastic and unattainable for all scenario, and MSMEs agree to achieve this target with a probability level of α . Approach with opportunity constraints is suitable for modeling the firm's profitability target Equation (11) as follows:

$$P(\sum_{i=1}^5 b_{1i} x_i \geq \pi \tilde{S}) \geq \alpha \quad (12)$$

Based on a stochastic goal programming approach and a chance constrained approach, the profitability objective function (Eq. (7)) is transformed into the constraint (Eq. (12)). The resulting certainty equivalent program to the multiple objective stochastic program (Eq. (8)) is as follows:

Objective function:

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

Subject to:

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

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

(13)

$$x_1 \leq 0,2 D$$

$$x_2 + x_3 + x_4 + x_5 = \text{TA}$$

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

3. RESULT AND DISCUSSIONS

To find the optimal level of working capital, we use data for the MSME in Surabaya for example. The data reported in this section were slightly modified to protect confidential information regarding the MSME in Surabaya. Additionally, for the sake of simplicity, we limit our presentation to three equiprobable states of nature for the level of sales ($N=3$) with $S(w_1) = 50$ million rupiahs, $S(w_2) = 100$ million rupiahs and $S(w_3) = 150$ million rupiahs. The average level of sales is $\bar{S} = 100$ million rupiahs and the standard deviation σ_S is 50 million. The micro enterprise has total assets TA of 50 million rupiahs and a debt level D of 10 million rupiahs (20 percent). The lower and upper limits, l_i and u_i , respectively, on the decision variables are presented in Table 2

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	
X1	Accounts payable
X2	Receivable turnover
X3	Inventory turnover
X4	Cash turnover
X5	Fixed asset

Table 3. Regression result

Dependent: Profitability

Variable	Standart coefficient	tstat	Pvalue	
X1	1.057	2.647	.014	Significance
X2	-.300	-.953	.350	Not significance
X3	-1.895	-3.844	.001	Significance
X4	-1.650	2.280	.031	Significance
X5	.365	.035	.230	Not significance

From the regression result on Table 3, we can see that accounts 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	
X1	2.048	.001	Significance
X2	-.356	.350	Not significance
X3	1.795	.004	Significance
X4	1.502	.021	Significance
X5	-.365	.230	Not significance

From the regression result on Table 3 and 4 we can see that accounts payable has a positive correlate to profitability and significance for significance level 5%. But inventory and cash turnover have negative correlate to profitability. In other situation, account payable, inventory turnover and cash turnover have a positive correlation to liquidity. Set profit margin π to 0.02 and probability of attaining the target profit α to 0.9. The net trade cycle (NTC) in the retail market is set to 100 days and the interest rate for short term investment $q(w_n)$ is set to 0.05 for all scenarios. The values of p_n set by 0,3;0,4;0,3 which its total equals 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

Z1	16,64
Z2	5,40
Z3	24,54
Z4	9,81
Z5	11,04
Max Z	67,418

The optimal solution obtained where a profitability level of 98,8 million rupiahs and a liquidity of 89.0834 million rupiahs (see Table 3). The optimal accounts payable value is 16.64 million rupiahs. The optimal accounts receivable value is 5.4 million rupiahs, a level that will stimulate product demand and strengthen the supplier-customer relationship. The higher level of accounts receivable compared to accounts payable indicates that the MSMEs aims to attract customers and smooth demand, and that the MSMEs suppliers are cautious about selling to the MSMEs on credit due to the lack of previous transaction history with the MSMEs. The high level of inventory will protect the MSMEs from unexpected distortions in the production cycle and mitigate unstable demand for the product but not too much because it would like adding the cost. The MSME holds a relatively high level of cash to act as a precaution against unfavorable liquidity events. This result is expected due to the high failure rate of MSME especially for micro business, which is caused mainly by financial and liquidity inadequacy. The optimal level of fixed assets is found to be at the lower limit, because the nature of the MSME business is that MSME' assets are mostly short-term.

4. CONCLUSIONS

In this paper, a stochastic multi-objective programming model is developed for optimizing the working capital of MSMEs in Indonesia. The proposed models are to get the optimal value of profitability and liquidity. The mathematical model is solved and the analysis results obtained are carried out using sensitivity analysis. Analysis of the result: account payable, inventory turnover, and cash turn over have a positive correlation for liquidity but inventory turnover and cash turnover have negative correlation to profitability. Lastly, future research can use the complete variable to have a best solution.

5. CONFLICT OF INTEREST

The Author declare there is no conflict of interest.

REFERENCES

- [1] Abuzayed, B., 2012. Working capital management and firms' performance in emerging markets: the case of Jordan. *Int. J. Manag. Financ.* 8 (2), 155–179.

- [2] Afrifa, G., Padachi, K., 2016. Working capital level influence on SME profitability. *J. Small Bus. Enterp. Dev.* 23 (1), 44–63. Aktas, N., Croci, E., Petmezas, D., 2015. Is working capital management value-enhancing? Evidence from firm performance and investments. *J. Corp. Finan.* 30, 98–113.
- [3] Almazari, A., 2013. The relationship between working capital management and profitability: evidence from Saudi cement companies. *Br. J. Econ. Manag. Trade* 4 (1), 146–157.
- [4] Autukaite, R., Molay, E., 2011. Cash holdings, working capital and firm value: Evidence from France. In: *International Conference of the French Finance Association (AFFI)*.
- [5] Baños-Caballero, S., García-Teruel, P.J., Martínez-Solano, P., 2012. How does working capital management affect the profitability of Spanish SMEs? *Small Bus. Econ.* 39 (2), 517–529.
- [6] Baños-Caballero, S., García-Teruel, P.J., Martínez-Solano, P., 2014. Working capital management, corporate performance, and financial constraints. *J. Bus. Res.* 67 (3), 332–338.
- [7] Ben Abdelaziz, F., 2012. Solution approaches for the multiobjective stochastic programming. *Eur. J. Oper. Res.* 216 (1), 1–16. BMI Research, 2016. Bahrain Retail Report.
- [8] BMI Research Fitch Company, U.K. Braun, M., Larrain, B., 2005. Finance and the business cycle: international, inter-industry evidence. *J. Financ.* 60 (3), 1097–1128.
- [9] Charnes, A., Cooper, W.W., 1963. Deterministic equivalents for optimizing and satisficing under chance constraints. *Oper. Res.* 11 (1), 18–39.
- [10] Cluttons, 2014. Bahrain Commercial Market Outlook.
- [11] Cluttons LLC. Contini, B., 1968. A stochastic approach to goal programming. *Oper. Res.* 16 (3), 576–586.
- [12] Dantzig, G.B., Madansky, A., 1961. On the solution of two-stage linear programs under uncertainty. In: *Proceedings of the fourth Berkeley symposium on mathematical statistics and probability*. Vol. 1. University of California Press Berkeley, CA, pp. 165–176.
- [13] De, P.K., Acharya, D., Sahu, K.C., 1982. A chance-constrained goal programming model for capital budgeting. *J. Oper. Res. Soc.* 33 (7), 635–638.
- [14] Deloof, M., 2003. Does working capital management affect profitability of Belgian firms? *J. Bus. Financ. Account.* 30, 573–587.
- [15] Eljelly, A.M., 2004. Liquidity-profitability tradeoff: an empirical investigation in an emerging market. *Int. J. Commer. Manag.* 14 (2), 48–61.
- [16] Fabbri, D., Klapper, L., 2016. Bargaining power and trade credit. *J. Corp. Finan.* 41, 66–80.
- [17] Fazzari, S.M., Petersen, B.C., 1993. Working capital and fixed investment: new evidence on financing constraints. *RAND J. Econ.* 328–342.
- [18] Ferris, J., 1981. A transactions theory of trade credit use. *Q. J. Econ.* 243–270. Gao, H., Harford, J., Li, K., 2013. Determinants of corporate cash policy: insights from private firms. *J. Financ. Econ.* 109 (3), 623–639.
- [19] García-Teruel, P., Martínez-Solano, P., 2007. Effects of working capital management on SME profitability. *Int. J. Manag. Financ.* 3 (2), 164–177.

- [20] Giannetti, M., Burkart, M., Ellingsen, T., 2011. What you sell is what you lend? Explaining trade credit contracts. *Rev. Financ. Stud.* 24 (4), 1261–1298.
- [21] Huyghebaert, N., Van de Gucht, L.M., 2007. The determinants of financial structure: new insights from business start-ups. *Eur. Financ. Manag.* 13 (1), 101–133.
- [22] Kaddumi, T.A., Ramadan, I.Z., 2012. Profitability and working capital management: the Jordanian case. *Int. J. Econ. Financ.* 4 (4), 217.
- [23] Keown, A.J., Martin, J.D., 1977. A chance constrained goal programming model for working capital management. *Eng. Econ.* 22 (3), 153–174.
- [24] Kim, C.S., Mauer, D.C., Sherman, A.E., 1998. The determinants of corporate liquidity: theory and evidence. *J. Financ. Quant. Anal.* 33 (3), 335–359.
- [25] Koumanakos, D., 2008. The effect of inventory management on firm performance. *Int. J. Product. Perform. Manag.* 57 (5), 355–369.
- [26] Lazaridis, I., Tryfonidis, D., 2006. Relationship between working capital management and profitability of listed companies in the Athens stock exchange. *J. Financ. Manag. Anal.* 19 (1), 26–35.
- [27] Lyroudi, K., Lazaridis, Y., 2000. The cash conversion cycle and liquidity analysis of the food industry in Greece. In: Working Paper. University of Macedonia.
- [28] Masmoudi, M., Abdelaziz, F.B., 2015. A chance constrained recourse approach for the portfolio selection problem. *Ann. Oper. Res.* 1–12.
- [29] Masri, H., Ben Abdelaziz, F., 2010. Belief linear programming. *Int. J. Approx. Reason.* 51 (8), 973–983. Padachi, K., 2006. Trends in working capital management and its impact on firms' performance: an analysis of Mauritian small manufacturing firms. *Int. Rev. Bus. Res. Pap.* 2 (2), 45–58.
- [30] Masri, H., Abdulla, Y. 2017. A multiple objective stochastic programming model for working capital management. *Technological Forecasting & Social Change.* 05 (006), 1-6.
- [31] Petersen, M.A., Rajan, R.G., 1997. Trade credit: theories and evidence. *Rev. Financ. Stud.* 10 (3), 661–691.
- [32] Rehman, M.Z., Khan, M.N., Khokhar, I., 2015. Investigating liquidity-profitability relationship: evidence from companies listed in Saudi stock exchange (Tadawul). *J. Appl. Financ. Bank.* 5 (3), 159–173.
- [33] Shin, H., Soenen, L., 1998. Efficiency of working capital management and corporate profitability. *Financ. Pract. Educ.* 8 (2), 37–45.
- [34] Smith, K., 1980. Profitability versus liquidity tradeoffs in working capital management. In: Smith, K.V. (Ed.), *Readings on the Management of Working Capital*. West Publishing Company, St Paul, MN, pp. 549–562.
- [35] Summers, B., Wilson, N., 2000. Trade credit management and the decision to use factoring: an empirical study. *J. Bus. Financ. Account.* 27 (1–2), 37–68.
- [36] Vahid, T.K., Mohsen, A.K., Mohammadreza, E., 2012. The impact of working capital management policies on firm's profitability and value: evidence from Iranian companies. *Int. Res. J. Financ. Econ.* 88, 155–162.

- [37] Weinraub, H.J., Visscher, S., 1998. Industry practice relating to aggressive conservative working capital policies. *J. Financ. Strateg. Decis.* 11 (2), 11–18.
- [38] Wilner, B., 2000. The exploitation of relationship in financial distress: the case of trade credit. *J. Financ.* 55, 153–178.
- [39] Zhang, Q., Huang, X., Zhang, C., 2015. A mean-risk index model for uncertain capital budgeting. *J. Oper. Res. Soc.* 66 (5), 761–770.