

# Application of ANNs and Dynamic Modeling for SMEs

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## Abstract

Indonesian SMEs Garment Manufacturers (ISGMs) has become the main contributor to Indonesia's Gross Domestic Product for the last ten years. At the same time, the State Minister for Cooperatives and SMEs received many reports on the discontinued of the ISGMs. Currently, the ISGM managers have lack of management capabilities. This study focus on the use of artificial neural networks (ANNs) that is capable of interpreting the results of financial statements analysis (FSA). ANNs rules are encoded implicitly using an algorithm for automatic learning. Furthermore, the study also will investigate how to support the ISGMs by using pattern recognition in dynamic modelling (DM). The combination of ANNs and DM may support the ISGMs in (1) analysing the firm's performance, (2) interpreting the results of FSA, and (3) providing a simulation on what will happen if something occurred in the business.

**Keywords:** financial statement analysis, ANNs, dynamic modelling, business, garment, SMEs

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## 1. Introduction

The paper reports on the use of two concepts for supporting Indonesian SMEs Garment Manufacturers (ISGMs). In the first concept, Artificial Neural Networks (ANNs) is used for analysing and interpreting the result of financial statements analysis (FSA) of ISGMs. In the second concept, Dynamic Modelling (DM) is used for providing a simulation on the firm's business performance. The simulation is based on pattern recognition and may enhance the ISGM manager's knowledge.

In the case of ISGMs, most of the owners of the firms also take the role as the manager. The ISGM owner-managers do not like to be supported by an expert's judgements because either they are reluctant towards a non-family expert or they cannot afford to pay the salary of the expert. In the daily operation, the ISGM owner-managers make decision based on their intuition. Intuition is not an irrational process; it is based on a deep understanding of what has happened in the business. However, a challenge arises when the new generation takes the place of the owner and become the novice manager. Most of the novice managers have neither a strong unconscious (or subconscious) knowledge nor a deep understanding of what has happened in the

business. Without adequate knowledge and experience, the novice managers suffer when competing with foreign garment manufacturers in the globalised world.

Using ANNs, the ISGM managers may make better decision by learning how to interpret the historical financial performances. Meanwhile, using the DM, they may increase their knowledge on the relationship between the firm's business performances with their strategies. The problem statement reads as follows: to what extent will ANNs and DM support an ISGM manager to survive in the globalised world?

## **2. The Challenges faced by the ISGMs**

This section briefly deals with the nature of the ISGMs. It presents the importance of Small and Medium Enterprises (SMEs) in the Indonesian economy, and the business challenges faced by the ISGMs.

Rice (2000a; 2000b) describes that SMEs are very important in Indonesian economy, in particular for (1) employment generation and (2) income generation. In 2008, 49.8 million SMEs absorbed 97.3% of the total employment in Indonesia. The SMEs contributed to 53.6% of the total Gross Domestic Product (BPS-Statistics Indonesia, 2008). Committee of Donor Agencies for Small Enterprises Development or CDASED (1998) mentions SMEs in Indonesia prove their strength to survive from economic crisis. The SMEs are able to survive because they are (1) more flexible and (2) quicker in decision making than those large enterprises.

In keeping with fact that manufacturing had the highest employment absorption level (42.18%) in Indonesia till 2007 (State Minister for Cooperatives and SMEs, 2008), this study will focus on ISGMs. Based on The Government of Indonesia (2008), the definition of medium-sized enterprise is determined by the amount of assets (500 million - 10 billion IDR, where land and building are excluded), and the amount of yearly sales (2.5 billion - 50 billion IDR). The reason for choosing ISGM as the focus is because the ISGM suffers of declining competitiveness in comparison with other developing countries, particularly China. In fact, when we calculated data from Indonesia Textile Association, there was 380% growth of imported China garment to Indonesia since 1999 to 2004. Surprisingly, the percentage was only from the official garment import; it even did not include the illegal garment import from China.

Manufacturing is one of the biggest contributors to Indonesia's Growth Domestic Product for the last ten years. Feridhanusetyawan, Aswicahyono, & Anas (2000) found that garment manufacturing has a flat kind of production pattern so they can survive during the economic crisis. One of the reasons that ISGM succeed to survive is because most of the companies produce an output that has a function as an input for other industries. These findings concur with those of Winarto and Gunawan (2008) who identified that ISGM can easily shift between domestic and international markets in responding to changing demands. Thus, although they still suffered from the crisis, they can minimize the negative impact.

However, at the same time, State Minister for Cooperatives and SMEs has received many reports about the discontinued manufacturing. As illustrated in Figure 1,

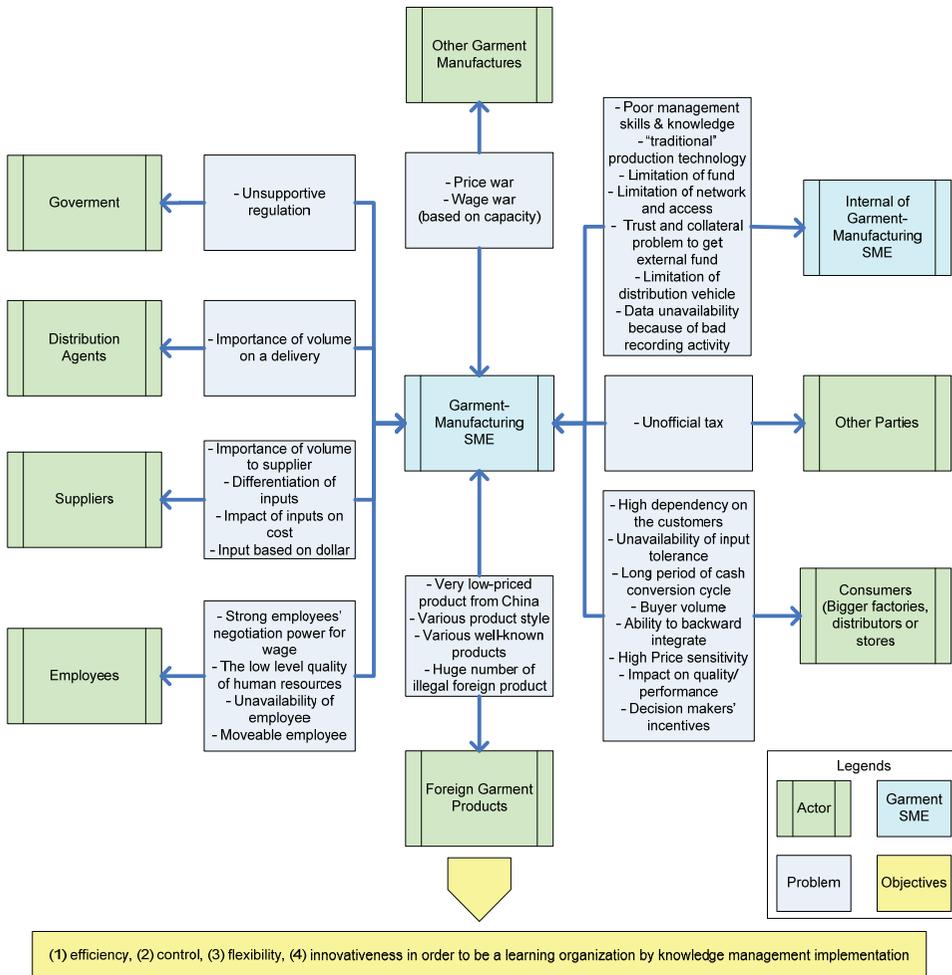


Figure 1. Problems faced by ISGM

ISGM faces abundant of internal and external challenges in their effort for achieving their business targets. Winarto and Gunawan (2008) argue that ISGMs have lack of knowledge and management capabilities. Most of the ISGMs use financial statements just for seeing their profit. They do not realise that financial statements can be used as indicators for monitoring and controlling their firms. Winarto and Gunawan (2008) demonstrate that an ISGM may have a huge amount of income but lower profit because of much higher costs than it should be. The high level of costs was caused by lack management control and unadequate decisions. Although the ISGMs successfully obtain profit from their daily activities, they suffer less and less profit because of inefficiency and internal frauds (Yesica & Gunawan, 2007).

The rapid technological development and the globalized competitions have brought a huge pressure for the ISGMs for reaching the international standards. Logically, the plummeting prices of information technology should allow SMEs to

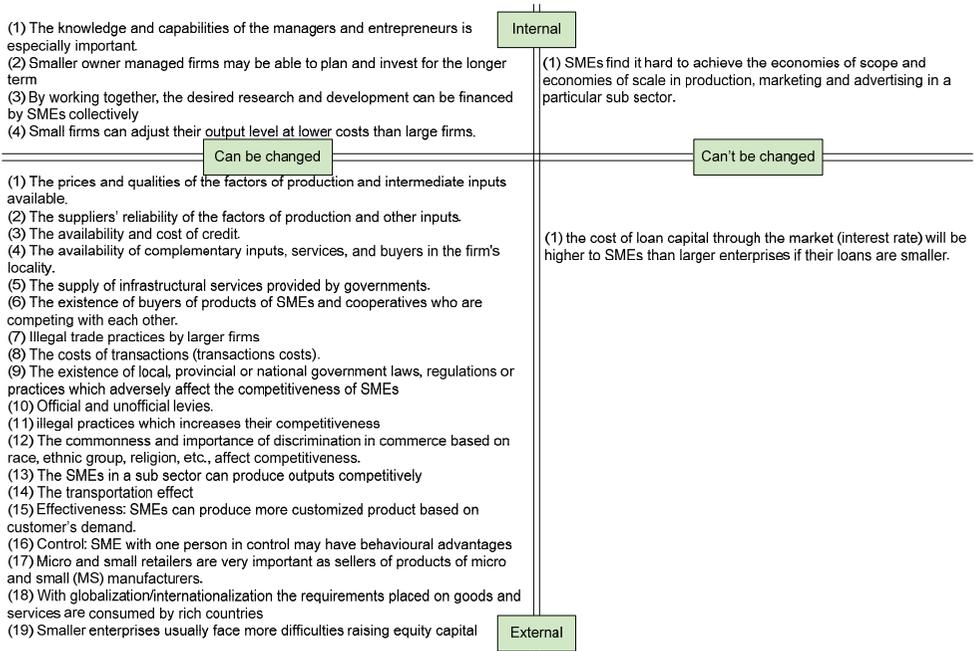


Figure 2. The Factors Affecting SMEs Competitiveness

compete with the large enterprises. The technology also should provide a chance for the SMEs to access mass markets in highly cost-effective and competitive ways (CDASED, 1998). Conversely, most of the ISGMs have (1) lack of capital, (2) lack of skills, and (3) problems in business development (Abduddin, 2006; Indarti, 2006 ). Those three factors are the determinants of the ISGMs' success. With these three kinds of weaknesses, the ISGMs cannot obtain the benefit of technological development and globalised market.

In order to obtain more capital from external parties, the ISGMs should provide a good business prospects. The business prospect may be enhanced by having good skills and good capabilities in business development. So, the ISGM managers should be supported in their effort in increasing their skills and capabilities in business development. One of the solutions is by supporting the ISGM managers, in particular the novice manager, with adequate knowledge. This aligns with Rice (2000b) who emphasised that knowledge and capabilities of managers are one of the most important SMEs' internal factors which can be changed, as illustrated in Figure 2. In this respect, by understanding historical financial performance and improving their capabilities by using the combination of ANNs and DM, the ISGMs will have greater chance for achieving economies of scope (demand-side changes) and economies of scale (supply-side changes).

### 3. How ANNs can support ISGM

Thee (2009) suggest three approaches which can be done by the Indonesia government for supporting the SMEs in Indonesia, namely (1) clamping down corruption by government bureaucracy (particularly the custom service), (2) providing legal certainty, and (3) issuing more business-friendly labour regulations. The three approaches by Thee need a full support from external parties, in particular the government (see Figure 2, the external section). In this study, we consider to support the ISGMs to have well-managed daily operations (Figure 2, the interaction between internal section and 'can be changed' section).

McMahon (2001) acknowledges that improved financial reporting combined with financial management will lead into better management of the ISGMs. Kristiansen (2004) identifies that knowledge of persons or institutions could strengthen ISGM business. By understanding the details and interaction of the business processes well, an ISGM manager may react efficiently and effectively in their daily operation. Supported by adequate ANNs methods, the ISGM manager may obtain adequate knowledge, in particular for transforming its historical financial statements data into qualified information. The qualified information is the result of pattern classification. Subsequently, the manager can use the pattern as a basis for monitoring the daily business activities and as the basis of his/her decision making. ANNs may help the manager in providing automatic pattern recognition. However, ANNs need qualified data from financial statements in order to compose the pattern recognition. Below we will define the data needed by ANNs from the financial statements and then followed by a brief explanation on the analysis processes conducted by ANNs.

Khan (1985) indicates that financial statements consist of significant information on the financial well-being of a firm. Financial ratios, as one of the products of financial statements, also can be used to develop statistical models that are quite successful as early-warning indicators of corporate bankruptcy. In line with Khan, Gitman (2009) indicates that ratio analysis involves methods of calculating and interpreting financial ratios to assess a firm's financial condition and performance. He divided financial ratios into several categories, such as: (1) liquidity ratios, (2) activity ratios, (3) leverage ratios and (4) profitability ratios.

Liquidity ratios can be measured by current ratio and quick ratio. Activity ratios can be measured by inventory turnover, average age of inventory, average collection period, average payment period, and total asset turnover. Financial leverage ratios can be measured by debt ratio, times interest earned ratio, and fixed-payment coverage ratio. Profitability ratios can be measured by (1) common-size income statements, (2) gross profit margin, (3) operating profit margin, (4) net profit margin, (5) earnings per share, (6) return on total assets, (7) return on equity, (8) price earnings ratio, and (9) market/book ratio. Finally, as an effort to analyze the firm's financial statements and to assess its financial condition, DuPont system can be used. It merges the income statement and balance sheet into two summary measures of profitability.

The financial ratios can be used for as the source of monitoring and evaluating activities. The information from the financial ratios also may support the manager's decision making. As an example, Bruinshoofd & Kool (2002) propose the use of

corporate liquidity ratio for increasing the quality of decision making. However, the majority of the ISGM managers don't understand how to analyse the results of those financial ratios. The ISGM managers need a support from financial expert for calculating, analysing, and interpreting the results of financial statement analysis (FSA). Khan (1985) emphasizes that the result of FSA serve only as indicators. It is up to the analyst to interpret the meaning of the FSA. For example, with a prior knowledge, a manager may interpret that a reduction in inventory turnover is normally undesirable. The reason is because the indicator reflects a conscious management decision to accumulate a scarce commodity. Without the ability to understand and to interpret the results of financial ratios, an ISGM manager will not be able to compete in the globalised world. McMahon (2001) suggests that the ISGM manager should be supported with a system that provides adequate knowledge.

Kroenke (2005) describes that knowledge management is the process of creating value from intellectual capital and sharing that knowledge with related parties. Matsatsinis (2002) describes that there are a variety of methodologies in developing an artificial intelligence, such as: multi criteria classification and sorting, linear programming, expert systems, neural nets, and machine learning. The ISGM managers can be supported by a knowledge-based system that generates human knowledge into machine learning (Wahdan, 2006). Wahdan emphasis that knowledge-based system can be used to help a company to (1) collect a complete set of information in the intelligence stage of decision making, (2) select significant information and alternatives in the design stage of decision making, (3) choose among alternatives in the choice stage of decision making, and (4) detect the weaknesses in the internal controls more effectively and efficiently. Berry and Linoff (1997) argue that data mining is an adequate technique for exploring large quantities of data and provides meaningful patterns and rules. The patterns and rules can be used in industrial process control. In this study, we use ANNs. Kryzanowski, Galler, & Wright (1993) emphasizes that ANNs has an ability to relearn relationship automatically from new examples as conditions change.

Based on Spronck (2005), ANNs are a network of interconnected neurons that can learn to emulate a (non-linear) function. The neurons can receive signals from other neurons via its incoming connections (input layer) and can send an output signal to other neurons via its outgoing connections (output layer). There are also neurons which are not located in those both layers and it is called as hidden neurons. A neural network must be trained to emulate a desired function by the help of a set of typical training samples or training set. He also stated that for neuron  $n$  the output signal  $O_n$  is calculated as follows:

$$O_n = f \left( \left( \sum_i w_i a_i \right) + b \right) \quad (1)$$

where  $w_i$  is a weight value attached to informing connection  $i$ ,  $a_i$  is the signal received via incoming connection  $i$ ,  $b$  is a bias value, and  $f$  is activation function.

Spronck (2005) also emphasizes that there are two common activation functions, namely: (1) a threshold function that maps the output of the neuron to either 0 or 1,

and (2) a sigmoid function that maps the output to a value in the range  $[0,1]$ . He then introduces four common neural-network architectures, namely: (1) a perceptron (contains an input and an output layer), (2) a layered feed-forward network (contains hidden neurons organized in a sequence of layer where each layer can receive input signals from immediately-preceding layer), (3) a general feed-forward network (contains hidden neurons organized in a sequence of layer where each neuron can receive input signals from all neurons in the input layer), and (4) a recurrent network (represented by a cyclic graph because it does not limit its connections to a feed-forward structure).

Kryzanowski and Galler (1995) introduced Boltzmann Machine (BM) as an effective tool for FSA. Although it is inherently slow, especially when the network grows, the algorithm of BM employs a technique of stochastic optimization (called simulated annealing). By the simulated annealing, BM provides optimal solutions. A manager may analyse the historical financial statements by observing pattern resulted by the BM. The manager should make pattern classification by assigning the firm to one of  $n$  categories ordered by the strength of the financial statements. The goal is to extract a set of key indicators or pattern of features from the raw numbers. Then, BM will use these features to find the best match of the item into the categories. So, the BM may handle complicated and interrelated FSA of the firm for the manager. However, because of probabilistic in nature, there is a possibility for having a situation where the same combination of features exist for items of different categories, but with different likelihoods. The financial experts usually use their prior knowledge and intuitive to solve this issue. Kryzanowski and Galler (1995) suggest to use Bayes decision theory to solve the problem. Bayes decision theory can be used to minimise the probability of error.

The neural network is the best choice because it is naturally suited to problems in pattern classification (Kryzanowski & Galler, 1995). ANNs is capable of formulating the expert's opinion on FSA, as expressed by financial expert. ANNs rules are encoded implicitly using an algorithm for automatic learning. The automatic learning function enables the ANNs to analyse and interprets the noisy data contained in the financial statements. Kryzanowski & Galler (1995) suggest that BM is able to support the ANNs to be an effective tool for FSA.

By using ANNs, first we can use input, output and hidden layer to represent a large class of simple, linear relations. Second, by using BM as supervised learning in ANNs, we use automatic methods for developing accurate weights in a network. Using BM, the weights in a network will automatically adjusted with another iterative methods. After an initial set of weight is assigned randomly, training patterns are presented to the network one at a time. For each patterns, preceding energy-reducing algorithm is used to set the states of the units. Then, the resulting output activations are compared to the correct outputs. Finally, the errors are recorded. After all the training patterns are used, the weight on each connection is adjusted. With this method, the observed error may be reduced and the training patterns are presented to the network repeatedly.

The pattern classification resulted from the ANNs then can be used in DM. With the combination of the ANNs and the DM, the ISGM managers may improve their

knowledge and capabilities. The simulation with up-to date historical financial data and adequate pattern classification may support the manager for performing better opinion in managing their firm.

#### 4. How DM can support ISGM

Morecroft (2007) proposes the use of models for composing simplification of the real world and for understanding the real world. With the simplification, an ISGM manager may try to understand on the relationship and the impact of their strategy to the firm's business performance. Zerlentes (2003) presents advantages of using DM. With the DM, the ISGM manager may predict short and long-term outcomes of their strategy. With the understanding on the possible outcomes from the strategy, the ISGM manager may make better decision.

Fogler (1974) shows that by adapting pattern recognition in the DM, additional information is utilised. Moreover, better forecasts may be resulted. The forecast provides a good illustration what may be happened if a specific strategy is conducted by the manager. With DM, the ISGM manager can simulate their decision based on real historical performance (with adequate forecast method). By doing the simulation, the manager will learn on which FSA indicator should be observed carefully, for instance the importance of lead time in inventory management.

#### 5. Conclusions

The importance of the study stems from the need of understanding the result of FSA. The ANNs can be used in formulating the financial expert's opinion on the result of FSA. With the use of DM, a simulation based on real historical financial statements data may provide a good learning experience for the ISGM manager. By using the simulation, the manager may obtain better understanding about (1) the business process, (2) the knowledge, and (3) the impact that will be occurred as the impact of his/her decision.

Supported by the combination of ANNs and DM, the ISGM managers will be able (1) to learn from their experiences, (2) to make better decision, and (3) to minimize the business risk by improving their knowledge (by doing simulation to get the likelihood feeling).

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