Faculty of Information and Communication Technology

PRODUCTION QUANTITY ESTIMATION USING AN IMPROVED ARTIFICIAL NEURAL NETWORK

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PRODUCTION QUANTITY ESTIMATION USING AN IMPROVED ARTIFICIAL NEURAL NETWORK

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DECLARATION

I declare that this thesis entitle "Production Quantity Estimation Using an Improved Artificial Neural Network" is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature :

Name : Raden Nur Rachman Dzakiyullah

Date : 26 March 2015

APPROVAL

I hereby declare that I have read this thesis and in my opinion this thesis is sufficient in terms of scope and quality as a partial fulfillment of Master of Science in Information and Communication Technology.

Signature :

Supervisor's name : Associate Professor Dr. Burairah Hussin

Date :

DEDICATION

"To my beloved Mother and Father"

"To my beloved Mother and Father in Law"

"To my beloved wife"

"To my beloved brother and sister"

ABSTRACT

By considering on the competitive market today, managing inventory becomes one factor that affected in improving business performance. This encouraged most industries to manage it efficiently by determining effective decision for inventory replenishment. For instance, mostly, industries decide next inventory replenishment by considering on their last historical production. However, this decision cannot be implemented on the next production due to uncertainty/fluctuated condition. Therefore, poor decision on producing product will influence the business' costs. Hence, this research proposes model based on Neural Network Back Propagation (NNBP) to estimate production quantity. This model is designed based on input variables that affect the determination of production quantity which include demand, setup costs, production, material costs, holding costs, transportation costs. The performance of NNBP can be analyzed using Root Mean Square Error (RMSE) and Mean Absolute Error (MAE). In order to increase the performance of NNBP, optimization techniques such as Genetic Algorithm (GA) and Particle Swarm Optimization (PSO) are being hybrid with the ANN model to become Hybrid Neural Network Genetic Algorithm (HNNGA) model and Hybrid Neural Network Particle Swarm Optimization (HNNPSO) model respectively. These techniques were used to optimize attribute weighting on NNBP model. The proposed models were examined using private dataset that collected from Iron Casting Manufacturing in Klaten, Indonesia. Moreover, validation is conducted for all proposed models through both Cross-Validation and statistical analysis. The cross-validation is common technique used to prevent over fitting problem by dividing the data into two categories namely data training and data test. Meanwhile, statistical analysis considers normality test on error estimation and the significant difference among the proposed models. Experimental result shows that HNNGA and HNNPSO provide smaller measurement error that concurrently improves the performance of NNBP model. In this work, the proposed model contributes not only to update the original instrument, but also applicable and beneficial for industry, particularly in deciding effective inventory replenishment decision on production quantity.

ABSTRAK

Melihat kepada pasaran yang kompetitif pada hari ini, pengurusan inventori menjadi satu faktor yang memberi kesan terhadap prestasi perniagaan. Ini menggalakkan kebanyakan industri untuk menguruskannya dengan cekap dan menentukan keputusan yang berkesan sewaktu penambahan inventori. Sebagai contoh, kebanyakkan industri menentukan penambahan inventori berdasarkan pengeluaran yang terdahulu. Walaubagaimanapun keputusan ini tidak dapat digunakan untuk menentukan pengeluaran yang seterusnya kerana aktiviti perniagaan selalunya tidak tetap/berubah-ubah. Oleh itu, keputusan yang buruk pada produk yang dihasilkan akan mempengaruhi kos perniagaan. Oleh itu, kajian ini mencadangkan model berdasarkan Neural Network Back Propagation (NNBP) untuk menganggarkan kuantiti pengeluaran. Model ini dibina berdasarkan pembolehubah yang memberi kesan dalam menentukan kuantiti pengeluaran termasuklah permintaan, kos penyediaan, pengeluaran, kos bahan, kos penyimpanan dan kos pengangkutan. Prestasi NNBP boleh dianalisis menggunakan Root Mean Square Error (RMSE) dan Mean Absolute Error (MAE). Dalam usaha untuk meningkatkan prestasi NNBP, teknik pengoptimuman seperti Genetic Algorithm (GA) dan Particle Swarm Optimization (PSO) digabungkan dengan model ANN menjadi model Hybrid Neural Network Genetic Algorithm (HNNGA) dan Hybrid Neural Network Particle Swarm Optimization (HNNPSO). Teknik ini digunakan untuk mengoptimumkan attribute weighting kepada model NNBP. Model yang dicadangkan ini diperiksa dengan menggunakan set data khas yang diperoleh daripada Iron Casting Manufacturing di Klaten, Indonesia. Selain itu, pengesahan dijalankan terhadap semua model yang dicadangkan menggunakan Cross Validation dan analisis statistik. Cross-Validation adalah teknik umum yang digunakan untuk mengelakkan masalah overfitting dengan membahagi kepada dua kategori iaitu data latihan dan data ujian. Sementara itu, analisis statistik mempertimbangkan ujian kenormalan pada anggaran kesilapan dan perbezaan yang signifikan di antara model yang dicadangkan. Hasil uji kaji menunjukkan bahawa HNNGA dan HNNPSO menyediakan ralat pengukuran yang lebih kecil yang meningkatkan prestasi model NNBP secara serentak. Dalam kajian ini, model yang dicadangkan memberi sumbangan bukan sahaja untuk mengemas kini cara yang asal, tetapi boleh digunakan dan memberi manfaat kepada industri terutamanya sewaktu memilih inventori tambahan yang berkesan untuk kuantiti pengeluaran.

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LIST OF ABREVIATIONS

AI	Artificial Intelligent
ANN	Artificial Neural Network
BP	Back propagation
NNBP	Neural Network Back propagation
EOQ	Economic Order Quantity
EPQ	Economic Production Quantity
GA	Genetic Algorithm
PSO	Particle Swarm Optimization
HNNGA	Hybrid Neural Network Genetic Algorithm
HNNPSO	Hybrid Neural Network Particle Swarm Optimization
PIM	Plastic Injection Molding
PQ	Production Quantity
FNN	Feed Forward Neural Network
CPU	Central Processing Unit
OS	Operating System
OR	Operation Research
RAM	Random Access Memory
GPU	Graphics Processing Unit
APPS	Application
PQEM	Production Quantity Estimation Model

LIST OF PUBLICATION

1. Nur Rachman Dzakiyullah, Burairah Hussin, Chairul Saleh, Aditian Maytri Handani with entitle "Comparison Neural Network And Support Vector Machine For Production Quantity Prediction", Advanced Science Letters, Volume 20, Number 10/11/12 (October/November/December, 2014), pp. 1731-2404 (SCOPUS SJR: 0.24).
2. Nur Rachman Dzakiyullah, Burairah Hussin, Chairul Saleh, Aditian Maytri Handani with entitle "Comparison Neural Network And Support Vector Machine For Production Quantity Prediction" Proceedings of the 2014 International Conference on Internet Services Technology and Information Engineering (ISTIE 2014), Bali, Indonesia, 31 May-1 June 2014.

CHAPTER 1

INTRODUCTION

1.1 Research Background

Nowadays, market competition among industries is addressed to meet customer requirement that deals with new product, rapid innovation of technology, short lifetime of product, unexpected consumer shifts and advances in industrial and information technology (Karim et al., 2008). In this case, most industries try to configure their business to improve manufacturing processes, operations and provide high quality product. This is the time when industries need to make a decision that could improve their business to become more effective and efficient (Karim and Zaman, 2013). In specific, industries need to consider the effective decision that even able to increase business performance.

The existence of computing technology has been linked to deal with the complex problems in the industry. This can refer to a collection of tools or techniques to help in decision-making and improve the business performance. Nevertheless, before the implementation of computing technology, it is important to first configure the decision level of organization. Bohanec (2009) stated that there are three hierarchical level of decision-making includes strategic, tactical and operational decision. Strategic decisions generally concern with the long term plan decision, tactical decision refer to the middle term plan decision or it has time horizons up to several months in length, and finally, operational decision characterized by short term decision for the daily or weekly activities on the shop floor.

According to Arif (2013), several research areas of computing technology application in decision making to solve industry's problem have presented in Fig 1.1.

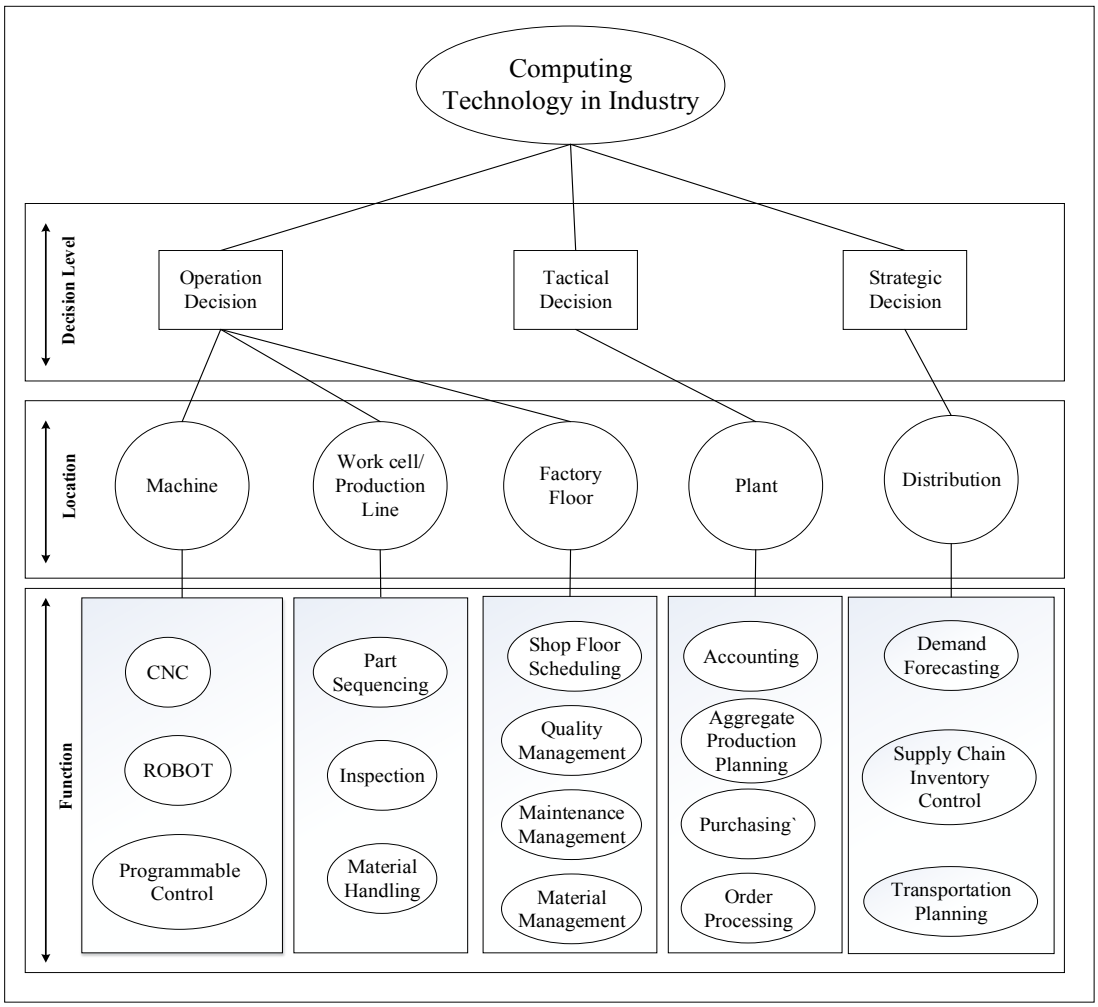

Figure 1.1 : The Use of Computing Technology.

As shown in Fig. 1.1, computing technology contributes to result effective decision that characterized based on the time scale and how far the decision can effects on the business performance. For example, strategic decision has been linked to the external organizations to control the inventory across the supply chain. Typically, this decision can made by negotiation among parties to achieve a long-term period goal. Unlike the strategic decision, tactical decision considers the monthly decision for production planning based on historical data to meet the customer requirement. Moreover, operational decisions are commonly

define as day-to-day activities for managing the business process such as part sequencing, inspection and material handling.

One of pointing problems in this study is the implementation of computing technology on inventory problems. It is due to inventory problems are the most combinatorial and hard to solve in the industry case study (Guner et al., 2010). These problems are associated with production planning problems that aimed to determine the production's period and the quantities of products to be produced. Therefore, determination of production quantity for inventory replenishment decision is categorized as tactical decision in order to satisfy demand. To make it clear, the next sub-section will discuss about the problems in inventory management and the application of computing technology to solve inventory problem.

1.1.1 Inventory Management Problem

Inventory can defined as keeping stock of good. Meanwhile, inventory management is an activity in ensuring the smooth mechanism in the process of purchasing, production and distribution (Heizer and Render, 2010). Inventory management focused in two activities such as when the inventory should be replenished and how much inventories that should ordered. The main objective of inventory management is to minimize the inventory cost. Inventory may consist of raw materials, work-in-process or finished goods. Inventory management becomes vital task in every industry since inventory represents about 20 up to 60 percent of total assets in manufacturing firms (Giannoccaro et al., 2003). In the past, most industries used push-inventory system, where the industry keeps producing the products or produces based on the demand forecast, hence the problem occurred when the actual demands do not match with the forecasted demand (Hirakawa, 1996; Bonney et al., 1999; Gutierrez et al., 2008).

The inaccurate estimation could possibly happen with high inventory and material shortage, which can affected the business 'cost. In this case, cost parameter is one of important factors that influence the production planning in an organization. It is also one of that most tangible and understandable economical evaluation for management and, therefore, many researchers have studied and proposed methods which are considered affect this factor mostly (Razmi et al., 1998). Poor decision in production quantity will effect to the imbalance replenishment decision, which also affect the incurred cost for holding, ordering, setup, production, material and transportation (Leuveano, 2012).

Most industries have been using well-known inventory analytical techniques to determine production quantity that called as Economic Production Quantity (EPQ) model (Mahata, 2012). The purpose of this model is to minimize the cost by determining optimal production quantity. Nevertheless, in order to obtain the optimal solution, the EPQ model is characterized by several constant variables such as constant demand and lead-time, constant cost, deterministic setup, no stock out and no shortage of items. Thus, it makes the model inaccurate in the real word manufacture environment (Paul and Azaeem, 2011; Li et al., 2011). It is due all variables in the models are always fluctuating in term of business market area.

In order to release the assumptions of the inventory model, this study proposes an implementation of computing technology to solve the complex problems in inventory management. Since the variables that influence the business' cost always fluctuate, hence computing technology is used to estimate an effective decision based on historical data. The computing technology techniques that used to develop estimation model will further discussed.

1.1.2 Implementation of Computing Technology in Industries

Implementation computing technology is usually concerned with decision making for industry problem. According to Ko et al. (2010), some research areas in industry that implement computing technology include: manufacturing flow/inventory management, order fulfilment, demand management, supplier relationship management, product development and commercialization, returns management and customer relationship management. Since this study focuses on inventory problem, then decisions can be made based on the fundamental question: how much products should be produced and when is the right time to execute the production. Thereby, computing technology has an important role in yielding an effective decision that simultaneously can improve the performance of the business.

Several techniques of computing technology for decision-making are: Artificial Neural Network (ANN), Fuzzy Logic (FL), Support Vector Machine (SVM), Evolutionary Computation (EC), Genetic Algorithm (GA), Particle Swarm Optimization (PSO), perhaps it can be a potential solution (Ko et al., 2010). However, among these techniques, ANN is the useful techniques that able to make a decision under the issues of fluctuated/uncertainty variables in the real system (Tanthatemee and Phruksaphanrat, 2012). Since ANN is a promising tool that can deal with linear and nonlinear variables (Ali et al., 2011). Moreover, ANN provides a learning process to the pattern data and able to process multivariable input-output and thus successfully becomes a model estimation that used for decision-making.

Recently, developments of the estimation model based on ANN are widely used in the field of economics, accounting and finance, business and marketing, health and medicine, engineering and manufacturing (Paliwal and Kumar, 2009). In this case, many researchers try to develop a model based on ANN to provide the effectiveness and better predictive capabilities. For example, the ANN can solve inventory problems by assisting