SEPA : Vol. 7 No.1 September 2010 : 15 – 22 *ISSN : 1829-9946*

VALUATION OF TOFU AGRO INDUSTRY'S PERFORMANCE USING BALANCED SCORECARD AND NEURO-FUZZY (A CASE STUDY IN BANYUMAS REGENCY, CENTRAL JAVA)

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Masuk 19 Agustus 2010; Diterima 6 September 2010

ABSTRAK

Salah satu UKM (Usaha Kecil dan Menengah) di Indonesia adalah kedelai dan tahu. UKM sangat rentan terhadap ketidakstabilan rantai pasokan, baik pada pemasaran dan perubahan harga bahan baku. Meningkatnya harga kedelai menyebabkan industri tahu perlu melakukan reorientasi strategi dengan meningkatkan kinerja dan daya saingnya. Tujuan dari penelitian ini sebagai berikut: 1) mengidentifikasi dan merumuskan kriteria dan variabel yang terlibat dalam proses penentuan kinerja bisnis berdasarkan aspek keuangan, pelanggan, proses bisnis internal, dan pertumbuhan dan pembelajaran dan 2) mengkategorikan kinerja di Desa Kalisari, Kabupaten Banyumas, Jawa Tengah melalui teknik neuro-fuzzy (ANFIS). Penilaian kinerja bisnis dapat dilihat dari beberapa aspek yaitu keuangan, pelanggan, proses bisnis internal, dan pertumbuhan dan pembelajaran. Setiap aspek juga terdiri dari beberapa kriteria yang saling mempengaruhi. Pada setiap tingkatan, setiap kriteria memiliki tingkat kepentingan yang berbeda. Salah satu fase penting untuk menentukan nilai kinerja adalah penentuan aturan. Terdapat 273 aturan yang dibangun dalam sistem ini. Perspektif keuangan merupakan penilaian kinerja berdasarkan data keuangan. Berdasarkan dari empat perspektif maka diketahui bahwa kinerja agroindustri tahu di Desa Kalisari, Kabupaten Banyumas, Jawa Tengah bernilai 2,21 atau dalam kondisi "tidak baik".

Kata kunci: Agroindustri Tahu, Sistem Penilaian Kinerja, BSC, Teknik Neuro-Uuzzy

INTRODUCTION

SME (Small and Medium Enterprise) is a strength of real strategic chartered investment counsel in national economy, with big number and disseminates to all rural. Djamali and Sugiyarto (2000) *in* Brata (2009), number of Indonesian business perpetrators in 2001 reached 40,197,611. From that amount, 99.86% is small business (40,137,773) and mostly is farmer in rural area. Number of medium scale business is 57,743 or 0.14%, and big business only 0.005% or 2.095 units (BPS, 2008 *in* Brata, 2009).

One of SME in Indonesia is soybean and tofu. Census of BPS in 2009 indicated that Central Java was Center of soybean cake and tofu's SME that is 37.1% of 42,954 SME in Indonesia. SME is fragile to instability of supply chain, either at marketing and changes of raw material's price. Industry small medium like soybean cake and tofu has special characteristic, i.e. most of production cost is for raw material. It has no problem if raw material can be fulfilled from within country (Irianto, 1996; BPS Banyumas Regency, 2009). Data from Ministry of Agiculture and Ministry of Trade in 2007 showed demand of soy for soybean cake and tofu industry in Indonesia per year reached 1.9 million tons and 1.3 million tons fulfilled from import (Asdrizas, 2008).

The increasing of soy price resulted tofu agro industry need to do strategy reorientation by increasing its performance and competitiveness (Disperindag Banyumas Regency, 2009). Study about the effect of soy price's increase to tofu agro industry performance in Indonesia seeing from the importance of soy price for the continuity of tofu industry is needed.

The objectives of this research as follows: 1) identifying and formulating criteria and variable involving in process of determining the

business performance based on financial, customer, internal business process, and growth and study aspects; and 2) categorizing work performance in Kalisari Village, Banyumas Regency, Central Java through neuro-fuzzy technique (ANFIS).

RESEARCH METHOD

Early detection to problems that is arising at a business hardly is required, so management is able to manage the problems swiftly and can apply policy that will implement. Business diagnose is a first way to know the business's health (Fraser and Ormiston, 2004; Babuška and Verbruggen, 2003). Firstly, it needs to know the essence of business itself by identifying it. Each component then identified again, and so on until ending factor. Then all components and activities analized to see the interrelationship between components. This interrelationship will explain about the factor that influencing business's health (Djarwanto and Pangestu, 2000). Research framework could be seen at Figure 1.

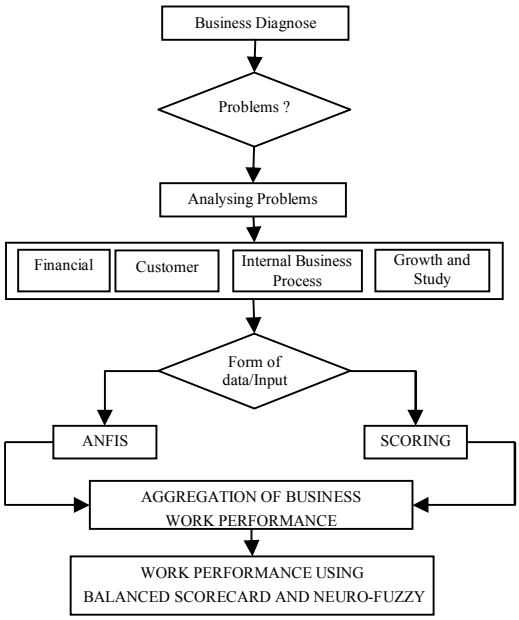

Figure1. Research Framework

Data collecting method applied in this research was from primary and secondary data. Primary data obtained by direct interview using questionnaire to the stka holders. Secondary data based on data found in institution related to research.

Research was done from July 6 until September 7, 2009 in Kalisari Village, Cilongok Subdistrict, Banyumas Regency. Method applied in this research was case study where primary data would processed and analyzed furthermore in detail which supported by questionnaire to know level of customer satisfaction, internal business process, and growth and study.

Methods of Analysis

1. Balanced Scorecard (BSC)

Valuation of performance is performance evaluation appraisal of organization. Organization performance valuation always based on target that reached, especially related to financial aspect (Jurmi, 2003). Kaplan and Norton (1996) mentioned that performance valuation of organization may not only pay attention to financial aspect, but also has took notice for non-financial aspect. For that purpose, Kaplan and Norton (1996) introduce performance valuation concept through Balanced Scorecard approach.

Balanced Scorecard is an appraisal method that balancing four perspectives of valuation, i.e. financial, customer, internal business process, and process of study and growth (Kaplan and Norton, 1996; Yuwono, 2001). In this method, financial performance is resulted from non-financial performance. In Balanced Scorecard, financial performance derived from ROCE (Return on Capital Employed), i.e. scorecard valution in financial aspect. It is an accumulation from product payment (goods and services), either by new customer and also by regular customer that expressing customer loyalty. Customer becomes loyal because satisfy with product (goods and services) given and velocity of product time. Both of this is result from internal process of organization. Improvement of organizational internal process could be passing by training, improvement of expertise and satisfaction of worker.

2. Artificial Neural Network (ANN)

According to Fauset (1994), Artificial Neural Network (ANN) is an information processing system having characteristics looks like biology neural network. (Chen and Leung, 2004), ANN is an elements processing group (associative neuron) where a subgroup (layer) does independent computing and continues result to next subgroup. ANN developed as mathematics model from Human Cognition or Neural biology (Woodford, 2000).

ANN architecture is plural layer architecture, which has input layer (x_i unit), hidden layer (z_i unit), and output layer (y_i unit) (Kamruzzaman and Sarker, 2004). Input layer has function to continue input and do not make computing. Hidden layer and output have function to do computing (Yordanov, 2004).

There are two study methods in ANFIS that are:

a. Back propagation Learning

Neural network of back propagation is artificial neural network that many applied for pattern recognition as optimization method. Because it is an ANN, hence this chain has architecture, training, and function of activation itself (Fausett, 1994)

b. Hybrid Learning

Study of hybrid is combination between back propagation with Least Squared Error (LSE). Study process hybrid, that is:

1) Forward phase

Study at this phase applies LSE, which is study of line OFF or static, because this study does not have dynamic element and there is no output feedback of ANN to input ANN. This study process functions to optimal the consequent parameter or minimize mistake (errors). Its action based on signal of output node, which is reference. Output of ANN will compared to reference and with study of LSE will be a selected error that is very minimum.

2) Backward phase

Study at this phase applies back propagation. This study process functions to optimal of premise parameter. Its action based on errors rate signal and like process of above back propagation

3. Fuzzy System

In daily application, it is hardly necessary for computer to be able comprehend man language. However, in the usage of language is very possible to meet characters of ambiguity, where it cannot finalize in ordinary logic processing (Alizadeh, *et al.* 2009). A numerical value can express in not precisely (fuzzy) like language value (linguistic) 'good', 'bad', etc. The language value is an example of fuzzy numbers. Therefore, it requires certain technique to overcome character of fuzzy. The fuzzy theory will applied to overcome constraint mentioned above (Klir and Yi, 1995; Ulrich, *et al*. 2007).

Fuzzy Inference System (FIS) is a formulation process of mapping from input to output by using fuzzy logic (Cord´on, *et al.* 2004). In general, FIS consisted of five functions, which are: (Leu, *et al.* 2008).

1. Rules, comprises number of orders fuzzy If-then
2. Database, defines member of function applied
3. Decision-making unit shows inference operation.
4. Fuzzyfication, distorting of single input to linguistics value appropriate.
5. Defuzzyfication, distorting of output fuzzy to monovalent output (crisp).

FIS model of Sugeno type firstly introduced at 1985's by Takagi, Sugeno, and Kang. The model is well-known as Takagi-Sugeno model (Woodford, 2000; Uncu, *et al*. 2003). Fuzzy rule in Sugeno model is in the form:

IF X = A and Y = B hence Z = F(X,Y)

where A and B is fuzzy cluster in antecedent; Z=F(X,Y) is function of crisp in consequent. F(X,Y) is polynomial with input variable X and Y. Output from Takagi-Sugeno model is in the form of constant linear.

Inference process at model Fuzzy Sugeno that are: (Klir and Yi, 1995)

1. Fuzzyfication, data input received and determined degree of membership. If condition is having multiple rules hence applied by fuzzy operator.
2. Fuzzy Operator, fuzzy operator is needed if antecedent for multiple rule, and applied to determine function of membership result of inference for every rule.
3. Inference, truth-value for premise from every rule is calculated and applied at part of conclusion of every rule.
4. Aggregation, amalgamation of all cluster fuzzy output becomes cluster fuzzy output.
5. Defuzzyfication, distorting process result of fuzzy becomes unique value (crisp).

4. ANFIS System

Neuro-fuzzy is inference technique that at most applied. This technique consisted of logic fuzzy and neural network (Jang, 1993; Full´er, 2000). Fuzzy logic applied as path control to think imitating, while neural network is functioning to determine maximum approach value from inference result (Atsalakis and Valavanis, 2008). Adaptive Neuro-fuzzy Inference System (ANFIS) is one of neuro-fuzzy technique.

Basic idea of ANFIS is building system applying artificial neural network in Fuzzy

Inference System (FIS) area (Franklin, *et al.* 1998; Casillas, *et al.* 2005). ANFIS applies FIS of Takagi Sugeno type and ANN with hybrid study or back propagation (Woodford, 2000).

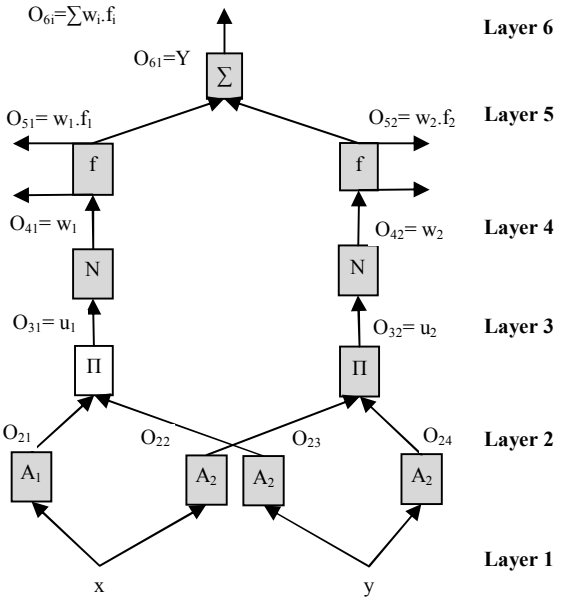

Figure 1. ANFIS structure

5. Model Design

a. Input Design

System input comes from financial performance during specified period that later on will be calculated ratios required by system. Besides input from financial aspect, input for other perspective got from business data processing, observation, and result of interview (Zhang and Wan, 2007).

Each indicator has level of different importance, thereby, it need weighting or in this case by pairwise comparation. Thereby, value packed into system is in the form of weighted indicators value (Saengrung, *et al.* 2007).

b. Output Design

Output from this system is the business performance value consisted in four perspectives that are financial, customer, internal business, and study and growth aspects.

c. Process Design

1) Input Process

Process at this phase has functions to enter or innovate data. Input data in the form of numeric variable is altering to become linguistics variable based on function of membership applied. Membership function applied at this system is Gaussian.

Artificial Neural Network (ANN) applied is back propagation. Study process applied is study observed with Delta rule method (Casillas and Martinez, 2007; Sivarao, *et al.* 2009.).

Purpose of performing training process at ANN is that certifiable ANN in recognizing input pattern in effort to obtain result target. Therefore, it is very important to train ANN with training set matching with duty of ANN itself in recognizing a pattern.

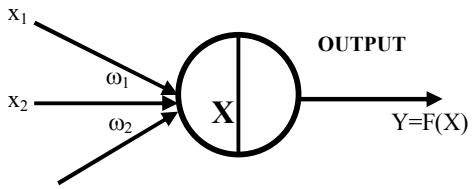

Figure 2. Artificial Neural Network

Whereas,

x_i	:	Input signal
ω_i	:	Weight of Link channel
X	:	Network input which is number from multiplications of input signal and its weight
Y	:	Function of network input
F	:	Linear function or other function that more complex

2) Valuation Process

Table 1. Indicators of performance valuation

PERSPECTIVE AND ASPECT	
FINANCIAL	
1. Growth	a. % growth of profit b. % growth of loan c. % growth of fund
2. Cost efficiency	Cost Recovery (CR)
3. Feasibility	a. Net Present Value (NPV) b. Internal Rate of Return (IRR)
CUSTOMER	
Customer Satisfaction	a. Tangible b. Reliability c. Responsiveness d. Assurance e. Empathy
INTERNAL BUSINESS	
1. Process quality	a. Competence b. Communication
2. Cyclic of Process	Development of new product
3. The success of organization development	a. Organization structure b. Award of work c. Manager behaviour d. Job characteristics
GROWTH AND STUDY	
1. Increasing employee capability	a. Level of education b. Training
2. Building harmonize of working environment	a. Amount of integrated worker b. Frequency of employee meeting

	c. Career development	
	d. Working satisfaction	
	e. SIM support	

Table 2. Configuration of fuzzy system and development of intelligent system

CONFIGURATION	DESCRIPTION
Fuzzy System	Takagi-Sugeno Ordo 1
Method "AND"	Minimum price
Method "OR"	Maximum price
Method "IMPLICATION"	Minimum price
Method "AGGREGATION"	Maximum price
Method "DEFUZZYFICATION"	Weighted Average
Learning Algorithm	Hybrid
Membership function	Gaussian

This phase is processing knowledge from input process. The purpose of this process is to know the business achievement (Preminger and Franck, 2007).

Table 3. Aspects of business performance valuation and their weights

PERSPECTIVE DAN ASPECT		WEIGHT
FINANCIAL		
1. Growth (0.152)	a. % growth of profit	0.550
	b. % growth of loan	0.210
	c. % growth of fund	0.240
2. Cost efficiency (0.152)	Cost Recovery (CR)	0.100
3. Feasibility (0.696)	a. Net Present Value (NPV)	0.667
	b. Internal Rate of Return (IRR)	0.333
CUSTOMER		
Customer Satisfaction (1.00)	a. Tangible	0.170
	b. Reliability	0.190
	c. Responsiveness	0.210
	d. Assurance	0.190
	e. Empathy	0.240
INTERNAL BUSINESS		
1. Process quality (0.333)	a. Competence	0.667
	b. Communication	0.333
2. Cyclic of Process (0.333)	Development of new product	1.000
3. The success of organization development (0.334)	a. Organization structure	0.210
	b. Award of work	0.340
	c. Manager behaviour	0.210
	d. Job characteristics	0.240
GROWTH AND STUDY		
1. Increasing employee capability (0.750)	a. Level of education	0.333
	b. Training	0.667
2. Building harmonize of working environment (0.250)	a. Amount of integrated worker	0.170
	b. Frequency of employee meeting	0.240
	c. Career development	0.190
	d. Working satisfaction	0.210
	e. SIM support	0.190

Table 4. Number of rule for each criteria

PERSPECTIVE/ASPECT/PARAMETER		RULES
FINANCIAL		104
1. Growth	a. % growth of profit	11
	b. % growth of loan	8
	c. % growth of fund	21
2. Cost efficiency	Cost Recovery (CR)	30
3. Feasibility	c. Net Present Value (NPV)	13
	a. Internal Rate of Return (IRR)	17
CUSTOMER		104
Customer Satisfaction	a. Tangible	19
	b. Reliability	21
	c. Responsiveness	19
	d. Assurance	18
	e. Empathy	23
INTERNAL BUSINESS		104
1. Process quality	a. Competence	11
	b. Communication	8
2. Cyclic of Process	Development of new product	21
3. The success of organization development	a. Organization structure	20
	b. Award of work	16
	c. Manager behaviour	17
	d. Job characteristics	11
GROWTH AND STUDY		104
1. Increasing employee capability	a. Level of education	20
	b. Training	17
2. Building harmonize of working environment	a. Amount of integrated worker	9
	b. Frequency of employee meeting	8
	c. Career development	16
	d. Working satisfaction	21
	e. SIM support	11

Determination process of business achievement based on quantifying fuzzy data processed with ANFIS (Kelemen, *et al.* 2002; Teshnehlab*, et al*. 2008). Indicators assessed in this system consisted of four perspectives. Hereinafter, more detail indicators assessed at Table 1. While system configuration applied is presented at Table 2.

RESULT AND DISCUSSION

Process of Performance Valuation

Performance valuation of business can be seeing from some aspects that are financial, customer, internal business process, and growth & study. Each aspect also consisted of some influencing criterions. At each level, every criterion has degree of different importance.

Process of Performance Value

One of important phase for the determining performance value is determining rule (Medeiros, *et al.* 2001; Kilic, *et al.* 2007;).

This methods specified based on interview and discussion with actors involving in this research. Forming of method made arrangements for every criteria of each in perspective of determination of performance (Peeters, 2008; Zarandi, *et al*. 2009). Number of rules built in this system were 273 Rules.

Financial perspective is resulted from performance valuation based on business' finance data (Kondadadi, *et al.* 2000). Briefly, business' finance data could be seen at Table 5.

Table 5. Weighted scoring and criteria of perspectives

PERSPECTIVE		WEIGHTED SCORING	CRITERIA
FINANCIAL			
1. Growth	a. % growth of profit	3.1	Above
	b. % growth of loan	2.6	Normal
	c. % growth of fund	3.9	Above
2. Cost efficiency	Cost Recovery (CR)	3.3	Above
3. Feasibility	a. Net Present Value (NPV)	3.9	Above
	b. Internal Rate of Return (IRR)	3.3	Above
TOTAL CRITERIA			**Good**
CUSTOMER			
Customer Satisfaction	a. Tangible	2.1	Below
	b. Reliability	3.0	Normal
	c. Responsiveness	1.9	Below
	d. Assurance	2.2	Below
	e. Empathy	3.3	Above
TOTAL CRITERIA			**Bad**
INTERNAL BUSINESS			
1. Process quality	a. Competence	2.1	Below
	b. Communication	2.5	Normal
2. Cyclic of Process	Development of new product	3.4	Above
3. The success of organization development	a. Organization structure	2.7	Normal
	b. Award of work	1.9	Below
	c. Manager behaviour	2.3	Below
	d. Job characteristics	2.1	Below
TOTAL CRITERIA			**Bad**
GROWTH AND STUDY			
1. Increasing employee capability	a. Level of education	1.7	Below
	b. Training	2.0	Below
2. Building harmonize of working environment	a. Amount of integrated worker	2.6	Normal
	b. Frequency of employee meeting	2.2	Below
	c. Career development	1.5	Below
	d. Working satisfaction	2.8	Above
	e. SIM support	1.9	Below
TOTAL CRITERIA			**Bad**
AGGREGATE OF TOTAL CRITERIA			**BAD**

Based on Table 5 could be known that performance of tofu agro industry in Kalisari Village, Banyumas Regency, Central Java from four perspectives was 2.21 or in "Bad" condition.

For customer aspect, internal business process and growth & study of input data based on result of observation, interview, distribution of questionnaire etc. Shortly, this table is depicted model of criteria determination.

Study Process of Fuzzy Inference System

Training process in this study is producing adapting result of performance valuation by study process of ANFIS. In this case, study was only in financial perspective (Tang, *et al.* 2005; Saengrung, *et al.* 2007; Majhi, *et al.* 2009). Weighted score in process of study was historical value, while assessing target was target that reached by a business. In this case, minimum is resided at normal condition (upper interval). Data training and target was present at Table 6.

Table 6. Historical and target value from FIS performance of financial perspective

No	HISTORICAL			TARGET
	Growth	Cost efficiency	Feasibility	Performance
1	1.42	2.03	2.94	4.33
2	2.14	1.54	2.69	4.54
3	1.92	1.40	1.08	3.63
4	1.44	2.12	2.33	4.42
5	1.52	2.82	1.76	4.53
6	1.32	2.36	2.91	5.50
7	1.32	2.73	2.41	5.52
8	2.21	2.56	2.70	5.32
9	1.52	1.25	1.72	3.38
10	1.55	2.98	2.10	4.36

CONCLUSION

1. Valuation of business performance can be seeing from some aspects that are financial, customer, internal business process, and growth & study. Each aspect also consisted of some influencing criterions. At each level, every criterion has degree of different importance. One of important phase for the determining performance value is determining rule. Number of rules built in this system were 273 Rules. Financial perspective is resulted from performance valuation based on business' finance data.
2. Performance of tofu agro industry in Kalisari Village, Banyumas Regency, Central Java from four perspectives was 2.21 or in "Bad" condition.

ACKNOWLEDGMENTS

We thank to Faculty of Agriculture Unsoed in supporting this study through a competitive grant of DIPA 2009 and Siti Wahyu Priyanti, student of Department of Agricultural Economics and Social Sciences, Unsoed for assisting during research.

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