Hybrid Profile Matching and Forest Fire Model Strategies in Serious Game Supply Chain Management Agribusiness

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***Abstract*— Supply Chain Management (SCM) is increasingly being recognized as the integration of key business processes across the supply chain. Any company that joined in SCM must consider the strategies of the firm's competitors. This research was discuss strategy in SCM agribusiness using hybrid profile matching and forest fire model and modelled in the form of serious games. Each cigarette factories compete to get tobacco from farmers in accordance with the required quality, so farmers can compete to sell tobacco in accordance with its quality. The results of the simulations revealed that supply of tobacco from farmers to the cigarette factory is distributed in stage.**

Keywords*—Supply Chain Management, serious game, agribusiness, profile matching, forest fire model*

1. Introduction

In formulating business strategy, the strategies of the firm's competitors must be considered by managers. In the business area, competition among enterprises cannot be ignored. If there is a single competition, it may be less important to analyse, but if competition occurs in some industries, the competition analysis needs attention.

Economic and financial environment is continues to expand. Information technology, growing rapidly, providing information on a global communications networks that is flexible. This condition causes the reaction of society faster and more frequent interaction between communities. The interaction between economic actors and the fast reaction cause a competition between companies is getting tougher.

Good market penetration can make newcomers to develop strategies that can serve as an entry wedge. The wedge entry enables new business ventures to successfully penetrate the market and win market share. The strategy is based on a sustainable competitive advantage. The strategy can lead to the availability of a new business with the wedge comes in, because it helps to build a new business in the market. [8]

This research develops competitive advantage in serious game Supply Chain Management (SCM) Agroindustry by using hybrid forest fire model and profile matching. Supply Chain Management is increasingly being recognized as the integration of key business processes across the supply chain. The core of SCM [4]: (a) Customer Relationship Management, (b) Customer Service Management, (c) Demand Management (d) Order Fulfilment (e) Manufacturing Flow Management (f) Procurement, (g) Product Development and Commercialization, (h) Returns. The eight key business processes run the length of the supply chain and cut across firms and functional silos within each firm.

The focus of this research is in order fulfilment of tobacco from the farmers to cigarette factory. The supply of tobacco from farmers to cigarette factory with the desired quality and the appropriate price is using a Profile Matching. The optimization of the tobacco's offer to cigarette factories that requiring with quality similar is using Forest Fire Model

The rest of this paper is organized as follows: The Literature review is described in section 2. The Methodology for hybrid profile matching and sandpile model strategies in the serious game of SCM agribusiness is discussed in section 3. Section

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4 discusses hybrid profile matching and forest fire model strategies in serious game SCM agribusiness analysis. Finally conclusions are given in section 5.

2. Literature Review

SCM is the monitoring and controlling of raw materials, information, and finances as they move in a process from supplier to industry to wholesaler to retailer to costumer. Various studies have been done related to SCM one of them is "The Order Fulfilment Process". This paper discusses the supply chain in motion, and filling them. Handling efficiently and effectively is a major step in customer's services. However, the order fulfilment process involves more than just filling orders. It is about designing a network and a process that permits a firm to meet customer requests while minimizing the total delivered cost [7].

This research proposed a profile matching to determine the suitability of tobacco held by farmers and which are needed by the tobacco industry. Profile matching has been developed in various domains. One of the studies is using the profile matching to find a profile of the framework through an approach that allows it to be assigned to the same person. This approach uses the weighting manually and automatically on attributes, string and semantic. The results of approach used to compare the value of the attribute aggregation function and will be used for data fusion and decision-making [5]. The other research is using the profile matching to represent each user's profile as a vector of personal data, which is an individual's profile. The comparison process consists of two phases: (1) The algorithm calculates a score similarity between vectors profile individuals using string matching function, (2) The weight vector is applied to the individual profile in common vector overall [9].

Profile matching in this study presented with a forest fire in hybrid model. A forest fire model is a dynamical system displaying self-organized criticality (SOC). The previous research develops the forest fire model to fulfil the settlement process in Real Time Gross Settlement. The mechanism of settlement is managed by clearing house. The transmitter client sends a message of transaction through transmitter bank that having canal at clearing house then continues to receiver client through receiver bank by using forest fire model.

3. Methodology

The physical environment of Cellular Automata (CA) is the universe of the CA that is computed. The physical environment of CA consists of a discrete lattice of cells. In this research, the physical environment of CA represent the part of Supply Chain Management System that manages the buying and selling of tobacco between farmers and cigarette factory. The cells represent the cigarette factory that requires tobacco for the production process.

Each cell can be in certain circumstances, these cells represent the state of cigarette factory conditions. The position of the cigarette factory has four possibilities, namely: a potential to buy, a potential to not buy, position being bought and positions have been bought.

For each cell representing the tobacco companies, the environment that consists of several tobacco companies that locally determine the evolution of the cell influences the SCM system. Environment consists of the cell itself plus the adjacent cell. In CA cell, there are some cells, for example, with a radius of 1 there is, in addition to the cell itself, there are four cells again located on north, east, south, and west adjacent cells (von Neumann neighbourhood), or the previous five cells, as well as the four north-east, south-east, south-west, and north-west diagonal cells (Moore neighbourhood) [1].

This rule acts upon a tobacco companies and its direct neighbour, such that the cell's state changes from one discrete time step to another (i.e., the system's iterations). The CA evolves in time and space as the rule is subsequently applied to all the cells in parallel. The rules evolution of CA can use deterministic or stochastic models. In this paper, using the model of CA stochastic evolution because the next step is not only determined by its neighbour cell but also the results of the calculation using the profile matching

The state of a cell (i, j) at the time t, can assume 4 values: (0) represents the "potential to buy", (1) represents the "potential for not buy", (2) represents the "being bought", (3) represents the "have been bought". The transition rules are [6]:

$$if\ N_b < 1, then\ < n \quad (0) \rightarrow (0) \qquad (1)$$

$$if\ \ N_b \geq 1\ \ then \begin{cases} (0) \rightarrow (2) with\ probability\ p \\ (1) \rightarrow (1) \\ (2) \rightarrow (3) after\ a\ time\ step \\ (3) \rightarrow (3) \end{cases}$$

The determination of the probability (p) in this research is using the ranking that is calculated by using profile matching.

4. Results and Discussion

The first step is measure the quality of tobacco from farmers (T1, T2, T3,....Tn) then ranked them using a Profile Matching. The profile matching needs the profile of tobacco as shown in Table 1. The profile of tobacco that required by cigarette's factory as shown in Table 2.

Table 1. Tobacco's Profile Owned by Farmer

No.	Criteria	Code	Factor
1	colour	P1*	Core
2	Smell	P2	Secondary
3	Size	P3*	Core
4	Thickness	P4	Secondary
5	Leaf wholeness	P5*	Core
6	Cleanliness leaves	P6	Secondary
7	The quality of mottle leaf's	P7	Secondary

Table 2. The Tobacco's Profile Required (TPR) by Cigarette's Factory

No	Cigarette's Factory	The Value of Criteria						
		P1	P2	P3	P4	P5	P6	P7
1	C1	4	3	4	3	3	3	2
2	C2	3	4	3	3	4	3	2
3	C3	3	3	4	3	3	3	4
4	C4	2	4	4	2	3	4	2

The next step is calculating the Gap. Gap is the difference between the values of each attribute with a target value. In this research, the gap is the difference between value of tobacco's profile that owned by farmers and the value of tobacco's profile that desired by cigarette factory

$$Gap = Atribut\ Value - Target\ Value \qquad (2)$$

The calculation of Profile Matching for the first company (C1) begins by calculating the gap of value of tobacco's profile that owned by farmers and the value of tobacco's profile that desired by cigarette factory.

Table 3. The Calculation of Gap

	Tobacco Id.	P1*	P2	P3*	P4	P5*	P6	P7	
1	T1	3	3	2	4	3	3	2	
2	T2	2	3	3	3	3	3	4	
3	T3	3	3	3	3	4	3	2	
4	T4	4	2	3	3	3	3	2	
5	T5	4	2	3	3	3	2	2	
6	T6	3	2	4	2	3	3	2	
7	T7	3	3	2	3	2	3	2	
8	T8	3	3	3	3	2	4	2	
9	T9	2	4	4	4	3	3	2	
10	T10	3	3	3	3	2	3	2	
	TPR	4	3	4	3	3	3	2	
1	T1	-1	0	-2	1	0	0	0	
2	T2	-2	0	-1	0	0	0	2	
3	T3	-1	0	-1	0	1	0	0	
4	T4	0	-1	-1	0	0	0	0	
5	T5	0	-1	-1	3	0	-1	0	Gap
6	T6	-1	-1	0	-1	0	0	0	
7	T7	-1	0	-2	0	-1	0	0	
8	T8	-1	0	-1	0	-1	1	0	
9	T9	-2	1	0	1	0	0	0	

10	T10	-1	0	-1	0	-1	0	0

After the gap of tobacco profile and requirement profile is calculated, the next step is weighting according to the table 4.

Table 4. The Weighting Based on Gap

Gap	Weight Value	
0	5	No Gap
1	4.5	P – TPR = 1
-1	4	P – TPR = -1
2	3.5	P – TPR = 2
-2	3	P – TPR = -2
3	2.5	P – TPR = 3
-3	2	P – TPR = -3
4	1.5	P – TPR = 4
-4	1	P – TPR = -4

The result of calculation using weighting according to the table 4 as shown in table 5

Table 5. The Calculation of Weights Based on Gap

	Id.	P1*	P2	P3*	P4	P5*	P6	P7	
1	T1	-1	0	-2	1	0	0	0	GAP
		4	0	3	4,5	5	5	5	Value
2	T2	-2	0	-1	0	0	0	2	GAP
		3	5	4	5	5	5	3,5	Value
3	T3	-1	0	-1	0	1	0	0	GAP
		4	5	4	5	4,5	5	5	Value
4	T4	0	-1	-1	0	0	0	0	GAP
		5	4	4	5	5	5	5	Value
5	T5	0	-1	-1	3	0	-1	0	GAP
		5	4	4	2,5	5	4	5	Value
6	T6	-1	-1	0	-1	0	0	0	GAP
		4	4	5	4	5	5	5	Value
7	T7	-1	0	-2	0	-1	0	0	GAP
		4	5	3	5	4	5	5	Value
8	T8	-1	0	-1	0	-1	1	0	GAP
		4	5	4	5	4	4,5	5	Value
9	T9	-2	1	0	1	0	0	0	GAP
		3	4,5	5	4,5	5	5	5	Value
10	T10	-1	0	-1	0	-1	0	0	GAP
		4	5	4	5	4	5	5	Value

The results of weighting are used to calculate Core Factor and Secondary Factor as shown in Table 6. The next step is to calculate the NP (Table 7). NP is used to determine the ranking of tobacco held by farmers to be accepted by the tobacco company SCM members (Table 8).

The calculation of core factor is using equation 3

$$NCF = \frac{\sum NC}{\sum IC} \quad (3)$$

The calculation of secondary factor is using equation 4.

$$NSF = \frac{\sum NS}{\sum IS} \quad (4)$$

Table 6. The Calculation of Core Factor (CF) and Secondary Factor (SF)

Id	P1*	P2	P3*	P4	P5*	P6	P7	CF	SF
T1	4	0	3	4,5	5	5	5	4	3.63
T2	3	5	4	5	5	5	3,5	4	4.63
T3	4	5	4	5	4,5	5	5	4.17	5
T4	5	4	4	5	5	5	5	4.67	4.75
T5	5	4	4	2,5	5	4	5	4.67	3.88
T6	4	4	5	4	5	5	5	4.67	4.5
T7	4	5	3	5	4	5	5	3.67	5
T8	4	5	4	5	4	4,5	5	4	4.88
T9	3	4,5	5	4,5	5	5	5	4.33	4.75
T10	4	5	4	5	4	5	5	4	5

The calculation of NP is using equation 5.

$$NP = 60\%\ NCF + 40\%\ NSF \quad (5)$$

Table 7. The Calculation of NP

	Id.	Core Factor	Secondary Factor	NP
1	T1	4	3.625	3.85
2	T2	4	4.625	4.25
3	T3	4.17	5	4.5
4	T4	4.67	4.75	4.7
5	T5	4.67	3.875	4.35
6	T6	4.67	4.5	4.6
7	T7	3.67	5	4.2
8	T8	4	4.875	4.35
9	T9	4.33	4.75	4.5
10	T10	4	5	4.4

Table 8 Ranked Tobacco Produced by Farmers in the cigarette factory C1

Id	Core Factor	Secondary Factor	NP	Rank
T4	4.67	4.75	4.7	1
T6	4.67	4.5	4.6	2
T3	4.17	5	4.5	3
T9	4.33	4.75	4.5	3
T10	4	5	4.4	4
T5	4.67	3.875	4.35	5
T8	4	4.875	4.35	5
T2	4	4.625	4.25	6
T7	3.67	5	4.2	7
T1	4	3.625	3.85	8

The next step is offers a tobacco to the cigarette factory that has similar profile with offered. By the same calculation, the ranked process for each company as shown in Table 8, Table 9, Table 10 and Table 11

Table 9 Ranked Tobacco Produced by Farmers in the cigarette factory C2

Id	Core Factor	Secondary Factor	NP	Rank
T3	5	4.75	4.9	1
T4	4.5	4.5	4.5	2
T10	4.33	4.75	4.5	3
T9	4.17	4.875	4.45	3
T1	4.33	4.625	4.45	4
T8	4.33	4.625	4.45	5
T5	4.5	4.25	4.4	5
T6	4.5	4.25	4.4	6
T2	4.33	4.375	4.35	7
T7	4	4.75	4.3	8

Table 10 Ranked Tobacco Produced by Farmers in the cigarette factory C3

Id	Core Factor	Secondary Factor	NP	Rank
T2	4.33	5	4.6	1
T6	5	4	4.6	2
T3	4.5	4.5	4.5	3
T9	4.67	4.25	4.5	3
T4	4.5	4.25	4.4	4
T10	4.33	4.5	4.4	5
T1	4.33	4.375	4.35	5
T8	4.33	4.375	4.35	6
T5	4.5	4	4.3	7
T7	4	4.5	4.2	8

Table 11 Ranked Tobacco Produced by Farmers in the cigarette factory C4

Id	Core Factor	Secondary Factor	NP	Rank
T9	5	4.375	4.75	1
T6	4.83	4.25	4.6	2
T2	4.67	4	4.4	3
T3	4.33	4.375	4.35	3
T8	4.17	4.625	4.35	4
T10	4.17	4.375	4.25	5
T1	4.17	4.125	4.15	5
T4	4.17	4.125	4.15	6
T5	4.17	3.875	4.05	7
T7	3.83	4.375	4.05	8

Cigarette Factory (C1), position (3,7), is "being bought". This factory buys tobacco (T4) with NP 4.7. If the excess tobacco then it will be offered at the cigarette factory neighbors SCM members who require tobacco with similar qualities to profile rank 1 on its needs. Cigarette Factory (C2), position (7,5), is "being bought". This factory buys tobacco (T3) with NP 4.9. If the excess tobacco then it will be offered at the cigarette factory neighbors SCM members who require tobacco with similar qualities to profile rank 1 on its needs. Cigarette Factory (C3), position (1, 4), is "being bought". It buys tobacco (T2) with NP 4.6. If the excess tobacco then it will be offered at the cigarette factory neighbors SCM members who require tobacco with similar qualities to profile rank 1 on its needs. Cigarette Factory (C4), position (4, 2), is "being bought". It buys tobacco (T9) with NP 4.75. If the excess tobacco then it will be offered at the cigarette factory neighbors SCM members who require tobacco with similar qualities to profile rank 1 on its needs. The Cigarette Factories (C1, C2, C3 and C4) as shown in Fig. 1.

0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	2	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	2	0	0
0	2	0	0	0	0	0	2	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	2	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0

Fig. 1. The Fulfillment Company by Farmers using Hybrid Profile Matching and Forest Fire

0	0	0	0	0	0	0	0	0	0
0	0	2	2	2	0	0	0	0	0
0	0	2	3	2	0	0	0	0	0
0	0	2	2	2	0	2	2	2	0
2	2	2	0	0	0	2	3	2	0
2	3	2	0	0	0	2	2	2	0
2	2	2	2	2	2	0	0	0	0
0	0	0	2	3	2	0	0	0	0
0	0	0	2	2	2	0	0	0	0
0	0	0	0	0	0	0	0	0	0

Fig. 2. Fulfillment Company by Farmers using Hybrid Profile Matching and Forest Fire (First Competition)

Fig. 2 shows the step second. The cigarette factories (position (3,7), (7,5), (1,4) and (4,2)) who make purchases distribute energy (tobacco farmers) to the cigarette industry neighbors. Cigarette factory (position (3,7)) distributes to the cigarette factory with the position (2,6), (2,7), (2,8), (3,6), (3,8), (4,6), (4.7), (4.8). Cigarette factory (position (7,5)) distributes to the cigarette factories that position (6,4), (6,5), (6,6), (7,4), (7,6), (8,4), (8.5), (8.6). Cigarette factory (position (1,4)) distributes to the cigarette factories that position (0,3), (0,4), (0,5), (1,3), (1,5), (2,3), (2,4) and (2,5). Cigarette factory (position (4,2)) distributes to the cigarette factories that position (3.1), (3.2), (3.3), (4.1), (4.3), (5.1), (5,2), (5,3).

Step 3 start going competition between tobacco farmers to offer their crops at a cigarette factory that has not made a purchase. In case it is considered that the price of fresh tobacco in accordance with the hierarchy of tobacco companies obtain tobacco first so C1, C2, C3 and C4 so the market that occurred in SCM as shown in Fig. 3, as well as for competition that occurs in the 4th phase as shown in Fig. 4.

0	2	2	2	2	2	0	0	0	0
0	2	3	3	3	2	0	0	0	0
0	2	3	3	3	p2	2	2	2	2
2	p2	3	3	3	p2	3	3	3	2
3	3	3	p2	p2	p2	3	3	3	2
3	3	3	p2	p2	p2	3	3	3	2
3	3	3	3	3	3	p2	2	2	2
2	2	p2	3	3	3	2	0	0	0
0	0	2	3	3	3	2	0	0	0
0	0	2	2	2	2	2	0	0	0

Fig. 3. Fulfillment Company by Farmers using Hybrid Profile Matching and Forest Fire (Second Competition)

2	3	3	3	3	3	2	0	0	0
p2	3	3	3	3	3	p2	2	2	2
3	3	3	3	3	3	3	3	3	3
3	3	3	3	3	3	3	3	3	3
3	3	3	3	3	3	3	3	3	3
3	3	3	3	3	3	3	3	3	3
3	3	3	3	3	3	3	3	3	3
3	3	3	3	3	3	3	p2	2	2
2	p2	3	3	3	3	3	2	0	0
0	2	3	3	3	3	3	2	0	0

Fig. 4. Fulfillment Company by Farmers using Hybrid Profile Matching and Forest Fire (Third Competition)

Stock condition that simulated using serious game SCM using concept as discussed above can be shown as in Fig. 5. Stock condition in Fig. 5 shows that the supply of tobacco from tobacco farmers to cigarette factories C1, C2 and C3 in stages.

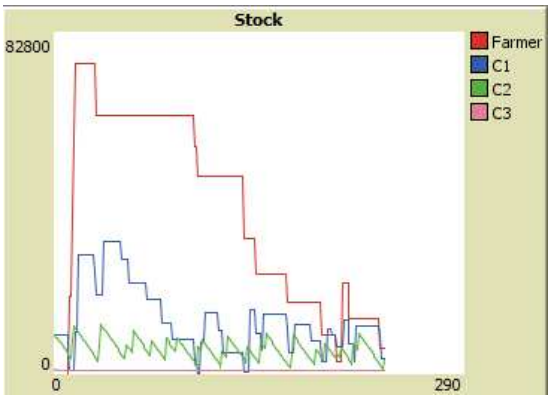

Fig. 5. Simulation of Stock Using SCM Agribusiness

5. Conclusion

Based on this study, the profile matching is used to measure the quality of tobacco farmers and make the ranking according to the needs of the cigarette factory. Based on the calculation of the Criterion tobacco needed cigarette factory first (C1) criteria (colour (P1) = 4, smell (P2) = 3, size (P3) = 4, thickness (P4) = 3, leaf wholeness (P5) = 3, Cleanliness leaves (P6) = 3 quality of leaf mottle (P7) = 2) and Tobacco offered T1 (with parameter P1 = 3, P2 = 3, P3 = 2, P4 = 4, P5 = 3, P6 = 3 and P7 = 2), T2 (with parameter P1 = 2, P2 = 4, P3 = 3, P4 = 3, P5 = 3, P6 = 3 and P7 = 4), T3 (with parameter P1 = 3, P2 = 3, P3 = 3, P4 = 3, P5 = 4, P6 = 3 and P7 = 2), T4 (with parameter P1 = 4, P2 = 2, P3 = 3, P4 = 3, P5 = 3, P6 = 3 and P7 = 2), T5 (with parameter P1 = 4, P2 = 2, P3 = 3, P4 = 3, P5 = 3, P6 = 2 and P7 = 2), T6 (with parameter P1 = 3, P2 = 2 , P3 = 4, P4 = 2, P5 = 3, P6 = 3 and P7 = 2), T7 (with parameter P1 = 3, P2 = 3, P3 = 2, P4 = 3, P5 = 2, P6 = 3 and P7 = 2), T8 (with parameter P1 = 3, P2 = 3, P3 = 3, P4 = 3, P5 = 2, P6 = 4 and P7 = 2), T9 (with parameter P1 = 2, P2 = 4, P3 = 4, P4 = 4, P5 = 3, P6 = 3 and P7 = 2), T10 (with parameter P1 = 3, P2 = 3, P3 = 3, P4 = 3, P5 = 2, P6 = 3 and P7 = 2), then the tobacco according to C1 is T4.

Based on the results of the profile matching the C1 position (3.7) on the physical environment of Cellular Automata Serious Game SCM Agribusiness with a number of requirements and purchasing power to make a purchase tobacco 3 T4 with NP 4.7 and subsequently distributing tobacco to the tobacco industry, namely neighbours cigarette factory with the position (2,6), (2,7), (2,8), (3,6), (3,8), (4,6), (4.7), (4.8), this distribution was continued in stages.

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