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Serious Game Dynamic Stock Agroindustry Product as a Production Planning using Cournot Model

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Abstract— **Stock management is an important part of Supply Chain Management (SCM). Stock dynamics in SCM agroindustry in this research was modelled by exploring SCM which was then simplified by using Cournot model. The results of this research can be used to monitor and create marketing strategies by agroindustry. Market structure will be an influential environment where agroindustry is located, if the environment is different, then the policies or strategies used in the market will also be different.**

Keywords—*Stock management, supply chain managemen, stock dynamic, cournot model, market structure*

1.   Introduction

Stock is a company asset that occupies a fairly important position in a company, both a trading company and an industrial company. Stock management is an important problem in supply chain management. Several analyses related to stock dynamics in supply chain systems can be found in the literature of the operations research community [1][2][3], [4]. In this model, we explore the supply chain of agro-industry networks that are simplified in the form of serious games [5].

There are farmers, who has limited stock. There can be many agroindustry, distributors and retailers. Agroindustry orders from upstream nodes and sends to downstream nodes. By selling goods, Agroindustry receives revenue. If the Agroindustry cannot fulfil demand, back-orders are made, penalty fees occur. Also holding inventory raises utilities and maintenance costs. Agroindustry strives to maximize their profits by wisely managing their ordering strategies and stock policies.

Daily requests are imposed on Agroindustry. Customers order from agroindustry and agroindustry orders from farmers. We assume that all agro-industries and customers follow a basic inventory policy, namely: after the stock position falls below the base stock level, Agroindustry orders the difference between the base inventory level and the current stock position; if you don't order anything. Customers will choose which agro-industry to order according to the order behind. Agroindustry needs to allocate available stock on hand to customers, according to their respective quotas. After all orders, fill, and ship activities are completed, we conclude the day and summarize costs and revenues for each Agroindustry. Then the new day begins.

This research emphasizes the stock distribution model in supply chain management. Market-determined prices are the result of a process of balance between supply and demand, that is, a stable compromise between the desires of several entities, called agents. Agents react in an independent manner with respect to information received from outside, but interact between them in decision making.

A very important aspect in dynamic stock is the individual perceptions of the market by agents and reactions that occur in microeconomic quantities [6]. On the other hand, the amount of stock is a macroeconomic quantity. So, at the same time, we can observe the transition model from the microeconomic structure to the macroeconomic quantity.

The process of transitioning from a microeconomic structure to a macroeconomic quantity that is very interesting to note is that volatility is the result of microeconomic fluctuations and volatility which is the result of macroeconomic fluctuations. Generally microeconomic or macroeconomic reactions have very different scale speeds [7]. Both

reactions are affected by changes in speed in the market.

This research developed the Serious Game Dynamic Stock Agro-Industry Product as a Production Planning using Cournot Model. The concept of SCM is an important part of modern management. The SCM concept consists of collaboration, planning, forecasting and replenishment [8][9][10]. SCM has been successfully developed in traditional companies, especially in manufacturing and retail. The results of these developments have shown increased performance and efficiency in coordinating transactions between suppliers and customers. However, the development of SCM in the agroindustry domain is still not widely discussed. Agro-industrial products have several properties, including, perishable, large/thick and quality variations. . The properties that are easily damaged and large/thick are very important in determining methods and storage, methods and means of transportation, and scheduling, especially in stock management. Based on observed variables, agro-industries can plan their stock of production materials well. In this research using the cournot model. Cournot builds the profit function for each company, and then, partial differentiation is used to build functions that represent the best response of the company to certain levels of output from other companies in the market [11][12].

The rest of this paper is organized as follows: The proposed model for serious game dynamic stock agroindustry product as a production planning using cournot model is discussed in section 2. Section 3 gives the result of serious game dynamic stock agroindustry product as a production planning using cournot model. Finally conclusions are given in section 4.

2.   The proposed model

Agricultural products are an important part of the global strategy to meet consumer demand while responding to changes in people's lifestyles. Agricultural products are affected by diverse weather conditions, alternative uses of agricultural production, unstable global food demand and volatility in commodity prices. These aspects cause the supply of agricultural products to be fragile which is expected to exceed the capacity limit in the coming years.

One of the most important difficulties in the food agriculture sector is the complexity and efficiency of logistics operations. This condition is caused by the characteristics of the raw material of the agricultural sector which is easily damaged. Modern global food agriculture networks require a supply chain management (SCM) approach. SCM is needed to overcome the increase in the flow of goods and information both upstream and downstream in the value chain and vice versa [13] as shown in Fig. 1.

In addition to the perishable agricultural raw materials, the complexity of the SCM model is also caused by emerging agribusiness retail outlets (ie fast food, main food retailers and catering service providers, etc.), large market segmentation, the need for vertical integration and horizontally, various different product offers, diversification of market needs, the presence of multinational companies in the food and retail processing sector, as well as corporate branding [14].
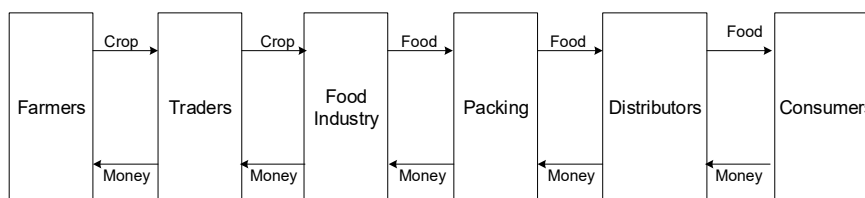

Fig. 1 Agricultural Supply Chain

The philosophy of agribusiness management modelling is the supply chain phenomenon that connects industry, suppliers and customers. In the supply chain, the industry connects to its upstream suppliers and downstream distributors to service its customers [15]. Usually, material flows forward while information and money flow backwards in a chain as shown in Fig. 2. The purpose of supply

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chain management is to provide the best service at the lowest possible cost.

The process that occurred in SCM in the past few decades has developed rapidly from the simple to the newly developed algorithm. With the concept of SCM process that continues to evolve, the SCM process has become a more important function. The SCM manager is given the responsibility to ensure that the supply chain runs efficiently and effectively, whether external or internal. The mechanism that must be followed for an effective SCM process involves the five basic stages [14] as shown in Fig. 3.
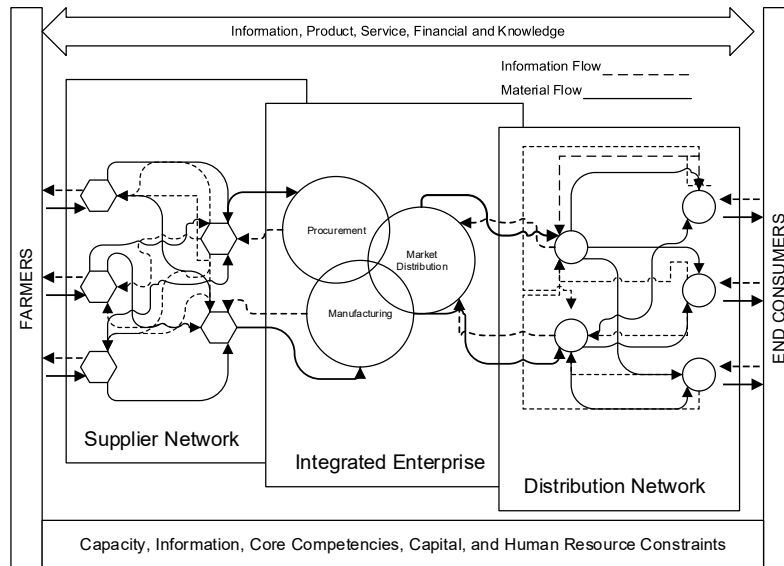

Fig. 2 Flow of Information, Product, Service, Financial and Knowledge in Agricultural Supply Chain
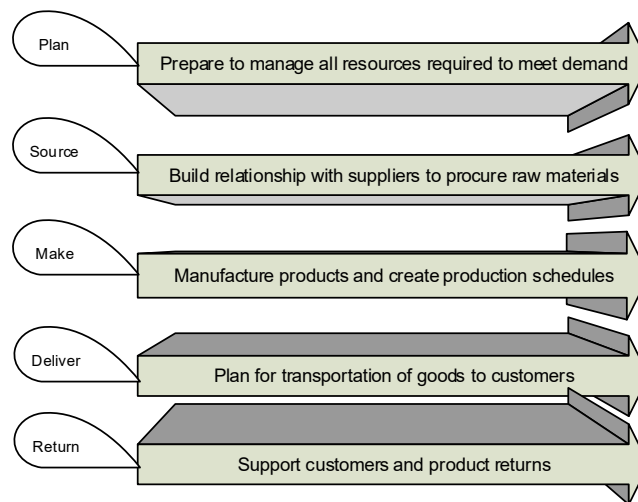

Fig. 3. Mechanism in Supply Chain Management

Plan; planning is an important part of the SCM mechanism. Planning becomes a determinant in order to fulfill the final requirements. The SCM manager must identify a list of key components such as location & factory size, warehouse design, shipping model, IT solution selection etc. Not only this, the SCM process will not be complete if key matrices such as transportation cost modelling, warehouse efficiency models, etc. are not developed.

Source; at this stage the emphasis is on certainty of raw material suppliers that can be relied upon to support the production process. The SCM manager must ensure the weak points of the supply cycle. This certainty is important to keep the production process running. The framework and selection of suppliers must ensure continuous development that will increase efficiency and effectiveness.

Make; this stage depends on the previous tenure, especially the planning stages. A well-designed process will result in a good implementation, so that the form of the product produced is ready to be tested, packaged and sent. Not only this, the results at this stage are quantified so that the maximum possible efficiency is achieved. The solution to IT use is believed to be a cost saving that enables customers to build excellence and improve efficiency at the stage of the SCM process.

Deliver; SCM manager at this stage has the task of providing the right amount of product / service, in the right place and at the right time using the appropriate operator. The SCM manager must be fully equipped with modern IT tools to store tracks in the warehousing network, inventory models, and invoices and receipts of payment.

Return; the completion of the return process is the final stage of the SCM process. At this stage not only involves reviewing returned products for quality purposes but also managing their inventory. At the basic level, SCM managers must mobilize all the resources they have to support the technology used so that they can work faster, return faster, etc. Return management must be a measurable parameter for increasing the value of SCM and they must ensure that every action taken must increase efficiency.

Based on the concepts and mechanisms that occur in SCM, this research developed a serious game of dynamic stock industry as a production planning using Cournot model. The model developed in this research is the cournot model. The main assumption of this model is that if the agroindustry "A" determines its production level, the changes made will not change the level of production. Based on this assumption, competitors will determine the level of production. In the duopoly market, there are only two companies that sell homogeneous products (Fig. 4), so there is only one market price. Market prices are determined by the

balance between total output produced by two agro-industries (agro-industry "A" and agro-industry "B") with market demand. The balance that occurs using the cournot model is determined by the intersection of the agroindustry "A" reaction and agroindustry "B"..

Production plans that maximize profits for agro-industry "A" will depend on how much the agro-industry "B" production plan and vice versa. In general, in the cournot model if there are two agroindustry in the market, each agro-industry will plan the stock or quantity to be produced precisely. After planning the amount of production, they will plan prices that are acceptable on the market.
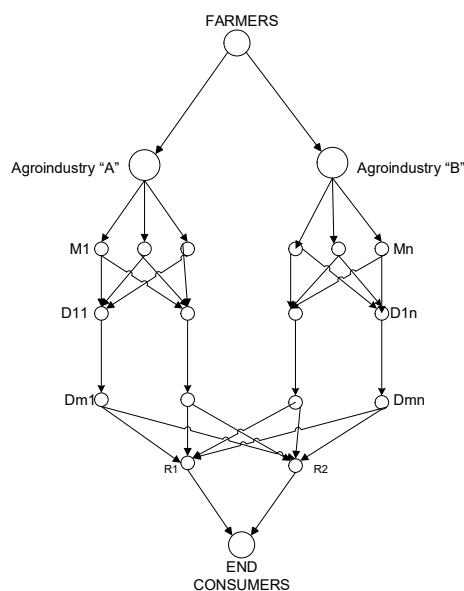

Fig. 4. Dynamic Stock Agroindustry Product as a Production Planning using Cournot Model

Agroindustry "A" and agroindustri "B" which are exemplified in this research have the Total Cost (TC) as follows:

$$TC_1 = 10Q_1 \qquad (1)$$

$$TC_2 = 10Q_2 \qquad (2)$$

Marginal Cost (MC) for agro-industry "A" and agro-industry "B" have a value of 10 per unit. If the value of $Q1 = Q2 = 10$, the Total Cost (TC) for the whole market is 100, so

$$P = 100 - Q_1 - Q_2 = 80 \qquad (3)$$

If the quantity of production planned in the market has been determined by the agro-industry "A"

which plans the quantity of production (Q1) to be marketed without ignoring the competing production quantity (Q2), namely agroindustry "B". Vice versa, agroindustry "B" will determine the quantity of production (Q2) considering also how much Agroindustry "B" production (Q1), then the price (P) will be determined.

3. Serious Game Dynamic Stock Agroindustry Product

Stock management is an important part of SCM. Stock dynamics in SCM agroindustry in this research was modelled by exploring SCM which was then simplified. Farmers have a limited supply distributed to several agro-industries to be processed into finished goods to be distributed to customers through retailers. Agroindustry orders from upstream nodes (farmers) and sends to downstream nodes (customer). By selling finished goods, agro-industries receive income. If the agro-industry cannot fulfil demand, back-orders are made, penalty fees occur. In addition to being subject to penalty fees, agro-industry as a stock holder raises utilities and maintenance costs. Agroindustry strives to maximize their profits by wisely managing the ordering strategy and stock.

Agroindustry will get maximum profit when Marginal Revenue (MR) is equal to Marginal Cost (MC). In times of such conditions and in a short time agroindustry will get economic benefits greater than zero. The consequence of new competitors if they do not monitor what happens to the market is a decrease in demand for incumbent agroindustry. If this condition continues, the profits of the incumbent company will decrease until the economic profit reaches zero (Fig. 5). The choice for incumbent agroindustry in these conditions is cost efficiency or increased innovation.
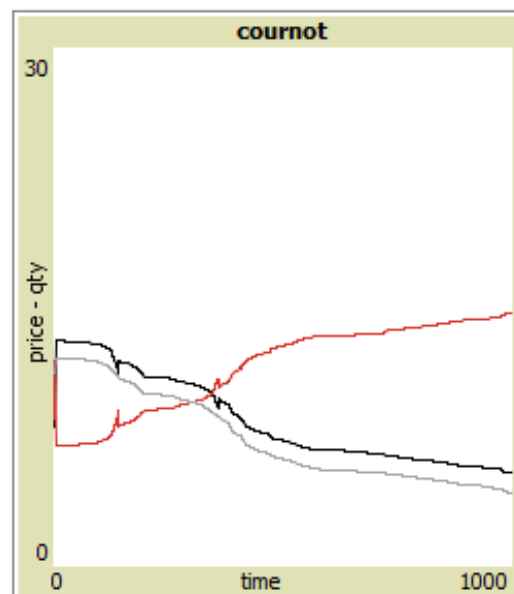

Fig. 5. The Cournot Equilibrium Market price and Quantity

At the time of the two agroindustry and two retailers competing in the market (Fig. 6), then at the beginning of competition there was a mutual compromise, so that the two agroindustry shared stock, as well as retail, but at a later moment there will be intense competition between agroindustry 1 and agroindustry 2 which at a certain time it will be controlled by one of the agroindustry, but retail will continue to share to be forwarded to the customer.

When two agroindustry share with each other, agroindustry conditions have begun to be identified. One of the agro-industries is stronger than other agro-industries. This condition can be analysed from the profits obtained by weak agroindustry which continues to decline until it reaches zero values. Meanwhile, retailers always share from stocks distributed by two agro-industries. Equitable distribution between two retailers causes profit conditions for each retailer to always be close to the same.

Market simulations consisting of one agroindustry and two suppliers (Fig. 7) show that existing stock in agroindustry follows market requirements. This market need can be monitored from the amount of stock in the agroindustry follows the value of existing stocks in suppliers. The condition of the stock following this led to profits between agroindustry and suppliers tending to rise together.
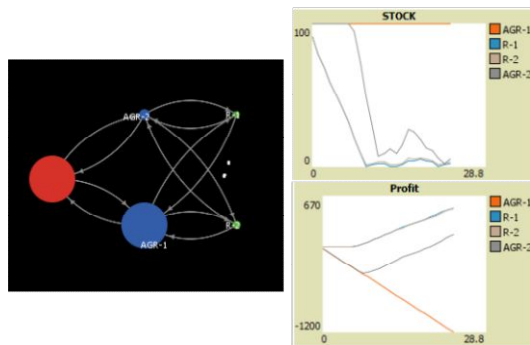
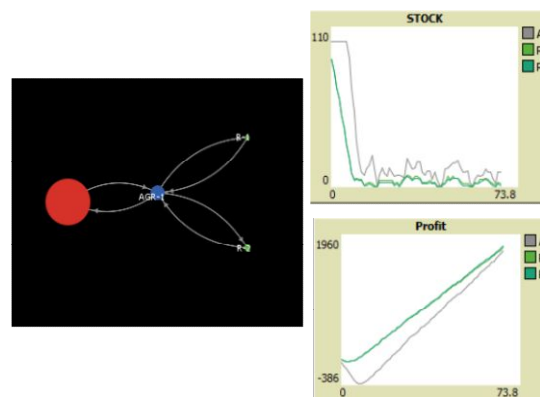Fig. 6. The SCM Consists of Two Agroindustry
and Two Suppliers

Fig. 7. The SCM Consists of One Agroindustry and
Two Suppliers

Simulations that occur when the market consists of 2 agroindustry and 1 supplier as shown in Fig. 8. In the SCM condition where there is a chain between two agroindustry and one supplier, then the stock for agroindustry-1 and agroindustry-2 at the beginning there was a mutual compromise, but this condition will change the next time and one of the agroindustry will dominate the market to follow the needs of suppliers. The losing agro-industry tends to continue to decline until it reaches zero.

The stock conditions of agroindustry and suppliers are also followed by profit conditions. The condition of the profit starting from the beginning has been identified that the agroindustry that controls the market has shown a higher profit compared to those that tend to decline. The profit from this weak.

The results of this research can be used to monitor and create marketing strategies by agroindustry. The resulting graph illustrates 1) market concentration, 2) number of agroindustry in the market, 3) equilibrium market prices and quantities, and Market Concentration (MC) in the market, 4) average profit of agroindustry in the market. Market Concentration is used to measure company accounts that are smaller than the total market percentage. This monitoring is used to determine the mastery of sales by one or more agroindustry in a particular market. The market concentration ratio is measured by the concentration ratio. Market structure will be an influential environment where agroindustry is located, if the environment is different, then the policies or strategies used in the market will also be different. Classification of the level of market concentration in this research is used to determine the market structure based on the level of market concentration.
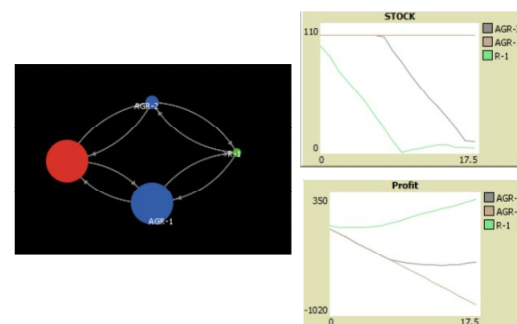

Fig. 8. The SCM Consists of Two Agroindustry
and One Supplier

4.   Conclusion

Stock dynamics in SCM agroindustry in this research was modelled by exploring SCM which was then simplified. The results of this research can be used to monitor and create marketing strategies by agroindustry. When two agroindustry and two retailers compete in the market, then at the beginning of the competition there is a mutual compromise, but in the future there will be intense competition. This condition results in the benefits obtained by weak agroindustry which continues to decline to zero. Market simulations consisting of one agroindustry and two suppliers indicate that existing stock in agroindustry follows market requirements. This stock condition causes profits between agroindustry and suppliers to tend to rise together. In the condition of SCM where there is a

chain between two agroindustry and one supplier, the stock for the two agroindustry at the beginning has reciprocal compromise, but this condition will change and one of the agroindustry will dominate the market to keep up with supplier needs. The condition of profits starting from the beginning has been identified that the agroindustry that controls the market has shown higher profits compared to those that tend to decline.

Acknowledgments

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