THE EFFECT OF DEMAND BEHAVIOR OF AUTOMOTIVE GLASS MANUFACTURER ON COST OF GOOD SOLD AND LOGISTICS PERFORMANCE THROUGH SYSTEM DYNAMICS APPROACH

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ABSTRACT

The existence of various changes in exogenous factors such as variations in market demand always responded in a way to be able to produce high-performance by the companies. It is indicated by the low level of operating costs and the level of customer order fulfillment rates. Problems often occur when production and distribution systems are not flexible in response to customer demand. By taking the object of research on automotive glass manufacturing companies, the simulation of system dynamics on the issues above have been developed. This research studied the influence of demands behavior that arise in the process of production. This system dynamics model was used to facilitate a number of scenarios in terms of looking for policies in response to consumer demand. The production policy is obtained by combining the two scenarios in which the impact of this merger could result in a low production cost and better logistics performance.

***Key words**: Automotive glass manufacturer, system dynamics, cost of good sold, and logistics performance*

1. INTRODUCTION

Successful corporate planning and policy design require that the company carefully coordinate the actions of the different functional areas, weigh short-and long run costs and benefits, and evaluate the impact of changes in business environment [Sterman], and [Warren]. These requirements preclude consistently effective planning based solely on managerial intuition and experience. Like other companies, automobile glass manufacturers are also facing the same thing.

In serving customers, the company produces various products such as flat glass, mirror glass and automotive glass. Especially for the automotive glass, there are two kinds of glass that is tempered glass and laminated glass. Requests is received every month from domestic and overseas customers. Domestic customers comprises customers OEM glass, spare parts and others. Meanwhile, overseas customers are generally only to meet the needs of spare parts in each country. Specifically to meet customer demand OEM glass regularly, the production system adopted is make to stock, thus the inventory of finished goods can be sent immediately if the request from the customer appears. Request that is received in the form of direct purchases generally have a few number of models and slightly fluctuated lower demand, while demand for spare parts both domestically and abroad showed the opposite characteristics, more variation in the model and the demand is irregular with high fluctuations, [Murray].

The variation in the model and the number of customer requests it will greatly affect the company's policies in running the system of production and distribution or logistics. This variation may also affect the performance of the process, becomes unstable and tends to result in high costs.

The objective of this paper is to study the behavior of the demand varieties of automotive glass manufacturer on cost of good sold and logistics performance.

2. THE DEVELOPMENT OF MODEL

Production and distribution of laminated glass system consists of three sub-systems namely order management or sales-marketing, production and warehousing and shipping or logistics. Subsystems is a series of interrelated to one another in the management of customer demand and order fulfillment processes of production. The general hypothesis shows in figure 1.

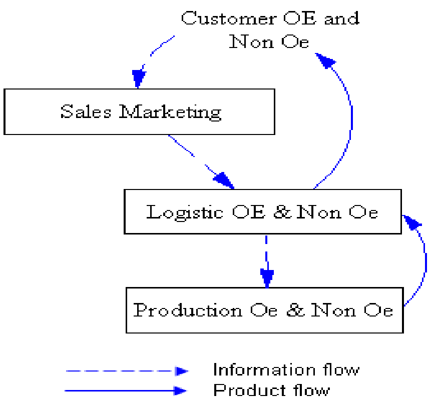

Figure 1. Production System of OE and Non OE of Laminated Glass

a. ***Sales-marketing subsystem***

Any orders received through Sales-Marketing in each month from a variety of OEM customers, spare parts and the Karoseri, both domestic and abroad. These orders at any time collected and expressed as the orders received. Each order contains information about the number that must be made and the date of delivery. Then this information is entered into the ERP system which will be used as guidelines for the production planning and logistics function. The increasing number of orders (market demand) will increase the acceptance rate of new order flow in which this will impact on the growing number of orders received and will continue to be pursued to increase until there is no difference between the received orders and orders desired level. This was later referred to as the monthly sales targets.

When the number of orders received go beyond the amount of order desired then any subsequent orders received is treated as an order next month. the desired number of orders, as sales targets, set by the confirmation obtained from the production planning of the production capacity available at any given time. The amount of orders received also will affect the magnitude of the backlog, [Chaovalitwongse et al], the larger the received order will cause the greater backlog of orders during the logistics process has not been done.

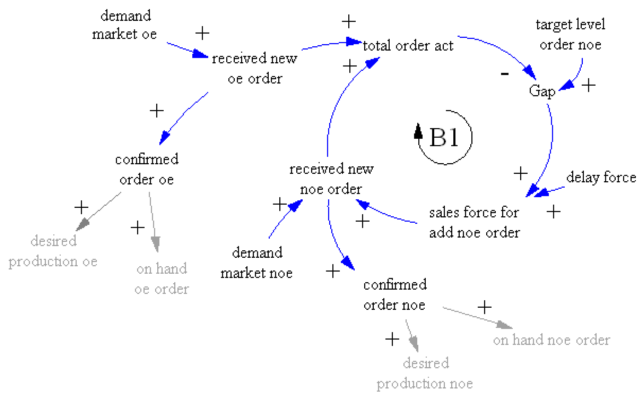

Figure 2. Sales-marketing Sub-system

b. Warehousing and shipping - logistics Sub-system

When the inventory of finished products stored in warehouses can meet the orders received, then the delivery will be carried out smoothly. This situation eventually will reduce the logistics capability to perform their duties, allowing of impending orders can not be sent, [Handfield et al]. various orders that have not sent in the schedule is expressed as the order backlog and this will continue to increase along with the lack of inventory in the warehouse. Figure 3 is a causal loop of warehousing and delivery for non-OE and OE. When an order backlog growing this will encourage greater the desired production which will give effect to the growing number of glass products to be shipped to the warehouse where the speed will depend on the carry-in rate. Thus this will increase the supply of glass in the warehouse to meet backlog orders. Increased inventory in the warehouse will encourage increased levels of shipments due to order backlog. This situation will further illustrate the many glass products are shipped to customers and the higher level of order fulfillment ratio. Delivery rate is affected by the magnitude of Desired delivery rate triggered by the magnitude of the order backlog.

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Increasing the level of order fulfillment, this will reduce the amount of backlog orders so that this loops process are a negative closed loop. For non-OE glass products, warehousing activities coupled with the process of packing because of customer demand these groups usually do not follow the standard amount of packaging. Packing speed is determined by the size of the packing rate. Packing rate and magnitude is influenced by packing desired rate and order backlog. So the magnitude of the order backlog will affect the magnitude desired delivery rate and packing rate.

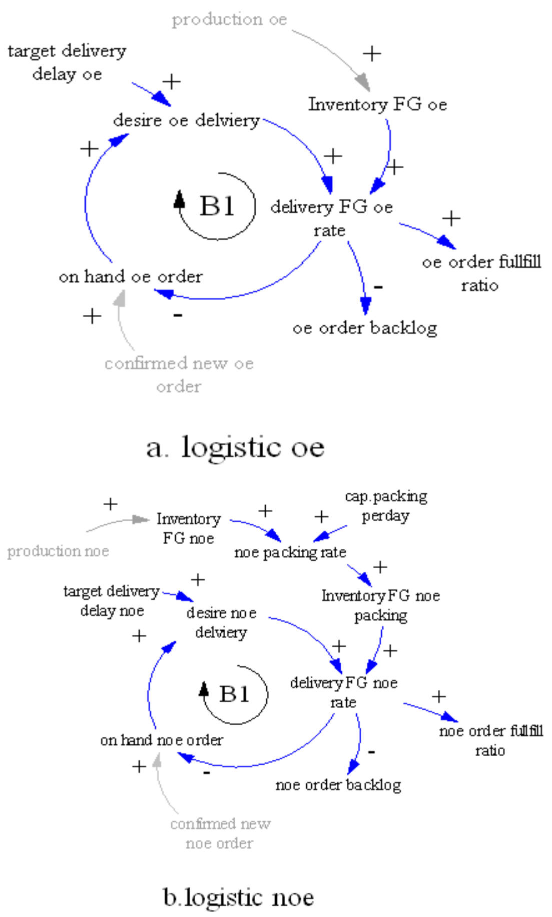

Figure 3 Logisctics Sub-system

c. Production subsystem

Production subsystem consists of a series of loops as shown in Figure 3. First is the loop of the fulfillment of production demands, starting from the desired production of *oe* and *non-oe*. Desired production is derived from the order backlog and desired inventory coverage. The first loop is a service desired ratio of inventories of finished goods to market demand where the larger of these values will lead to further increased production demand also needs to be scheduled. Also, this loop will further spur the production process to operate which will be influenced by the speed of the process of cutting rate, bending rate, lay-up rate, prepress rate, autoclave rate, trimming rate until inpection rate in order to produce laminated glass in accordance with the desired amount . Each of the process speed rate is determined by the amount of capacity that depends on the percentage of process defects, lot size production, downtime and production time available each month for the process concerned. Some processes such as cutting and bending, its capacity is determined also by the number of models being operated. Preparation time required when switching products, preparation of operation, waiting time completion of production lot, or the interruption process. All these processes lead to work in process (WIP). WIP is also required as well to balance the capacity between processes. WIP is always there in every process except the lay-ups and prepress because both processes are directly connected. Additional production process is continued until the entire production demands are met. In other words there is no difference between production demand and inventory.

The first linkage is formed a negative loop of the overall production system, which means the process will continue until equilibrium is reached. The second and third loop associated with WIP inventory process improvement as a result of a defect in which the process can still be improved as bubble and the scratch. The second and third loop is positive means that both the loop's function is enlarge the number of products produced. Final examination is the final process of manufacturing laminated glass, then glass is transported and delivered to the repository through the process of carry-in.

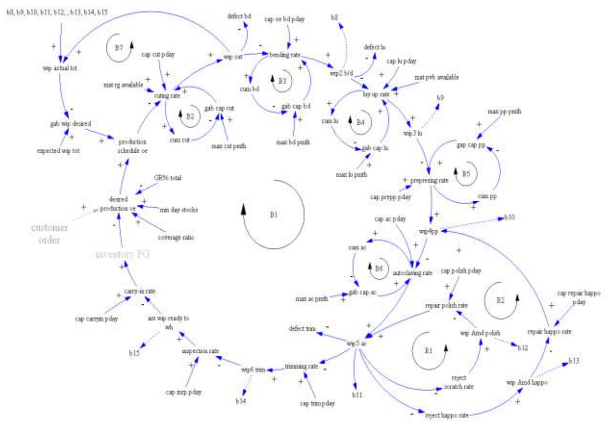

Figure 4 Production Sub-system of *oe* and *non oe*.

3. RESEARCH METHOD

Parameter Sensitivity Analysis

Sensitivity of model response to a stimulus is indicated by changes in behavior and performance models. Stimulus is done by providing a specific treatment on the model structure. The effect of such measures is observed through a change in reference value (reference mode) representing the performance of the model. Before testing the model, sensitivity analysis was performed first to find out the parameters of the high leverage or a lever model performance. When changes are made to increase or decrease of 10% on any parameters tested from the initial value, the resulting value will be compared and seen its effect on the behavior of the overall system performance. Table 1 shows the results of testing the sensitivity of each parameter.

4. RESULT AND DISCUSSION

A number of parameters to be high leverage of test results is % good ratio, set-up, down time, the number of initial inventories of WIP and finished goods, while the lot size production, as well as the ratio of stock of finished goods has a sufficient sensitivity. To answer the problems faced as we mentioned at the beginning of this article, the parameters having a high level of sensitivity was tested further for a wider range of variation in order to know the best model performance.

4.1 Policy Scenario

Policy scenarios to be constructed is to obtain the ideal behavior in the future that could reduce the influence of variables including high leverage as described previously.

Scenario 1 : This policy scenario focuses on the efforts of the planning function to make the adjustment of production by increasing the size of the production lot size oe, increasing the initial inventory of finished good and the decline of the ratio of finished good stock oe.

Scenario 2 : This policy scenario focuses on the production effort to increase productivity by reducing down-time, set-up time, increased the percentage of good process and the reduction ratio variation of process defects.

Scenario 3 : This policy scenario is a combination of scenario 2 and scenario 3 with no reduction in finished good stock ratio of oe.

4.2 Results

In accordance with the purpose of this research is to formulate the policy scenarios of appropriate production strategy which can be used to improve company performance. Strategic policy in question is a policy that has the lowest impact on the performance of laminated glass production system. On the basis of conditions in which the system is running as usual without any visible intervention order fillrate decreased over time. The basic model in which the initial availability of finished good inventory is sufficient, order fill rate of non oe can still be maintained for approximately 81.4% but at month-2 decreased to 75.1% and the subsequent relatively stable at 75.7%. This indicates that the system of production has shown the capacity of the existing reality without the intervention of inventory. While the cost of production is still quite profitable for the company because it is below the price of the product (COGS ratio <1), from month 1 of 0.856 slightly decreased to 0.855 at month 2 and 3 due to low inventory levels and maintenance of finished goods in the warehouse.

Scenario 1 focuses on the planning to make the adjustment of production by increasing the size of the lot size oe production, increasing the initial inventory of finished good and minimize the ratio of finished good stock of oe. From the analysis of the basic conditions can be seen that the size of the lot size increases by 2 times the lot size basis, the increase of the initial inventory of finished good non-oe up to 1.0 of the basic conditions showed the best performance results from the production system. Simulation of scenario 1 gives the following results: non oe order fill rate increased in month 1, month 2 and month 3, respectively of 2.4%, 5.7% and 11.2%. The situation in scenario 1 is able to reduce the cost of 0.39%, 0.67% and 0.92% of the basic conditions. But on the other hand, scenario 1 can also cause a drop in the order fill rate oe at month 3 to 97.7% where it should not happen.

Scenario 2 focuses on the production effort to increase productivity by reducing down-time, set-up time, increase the percentage ratio of good process and variation reduction of process defects. From the analysis of the basic conditions can be seen that the down-time 5% less, set-up time is faster 8% of the base, and good ratio of 94% total yield the best performance of production systems. Simulation scenario 2 gives the following result of non oe order fill rate increased at 1, 2 and 3, respectively of 2.4%, 4.5% and 9.1%. Similarly, scenario 2 is able to reduce costs by 2.9% against the baseline conditions while maintaining the order fill rate remains 100% oe.

Scenario 3 is a combination of scenario 2 and 3 without reduction in finished good stock ratio oe. Simulation of scenario 3 gives the following results : non oe order fill rate increased at month 1, 2 and 3, respectively of 2.4%, 5.8% and 11.1%. Scenario 3 is also able to reduce costs better than scenarios 1 and 2 amounting to 3.1% of the basic conditions while maintaining the order fill rate of oe remains 100%.

5. CONCLUSION

Since the purpose of this study in addition to seeing the influence of endogenous factors and also to find a strategic policy scenario of laminated glass production and distribution system proper, then the scenario chosen is the scenario that supports that goal. From the simulation results of various scenarios that have been done then the third scenario is chosen because it provides the best performance value for the company, both at the level of fulfillment of an order fill rate of customer demand and the level of operational costs of production. Scenario 3 is an overall improvement efforts of the manufacture of laminated glass production systems both to improvements in the production planning as well as improvements in the production process itself in terms of increased productivity and an increase in the percentage ratio of good process and the reduction of variation of process defects.

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Table 1 Sensitivity of Model Parameters

Parameters		10 % Increase of Base Value[a]			10 % Decrease of Base Value[a]			Less sensitive	Sensitive	Very Sensitive
		Order fill rate oe	Order fill rate non oe	COGS	Order fill rate oe	Order fill rate non oe	COGS			
Market Demand	Quantity of oe	100%	81.4%	0.856	100%	81.5%	0.856		**	
	Quantity of non oe	100%	83.9%	0.856	100%	82.0%	0.856		**	
	Product Variety of oe	100%	81.4%	0.856	100%	81.4%	0.856	*		
	Product Variety of non oe	100%	81.4%	0.856	100%	81.5%	0.856		**	
Production	Quantity of oe	100%	81.7%	0.856	100%	81.0%	0.856		**	
	Quantity of non oe	100%	82.1%	0.802	100%	46.3%	1.141			***
	Product Variety of oe	100%	81.0%	0.857	100%	81.8%	0.857			***
	Product Variety of non oe	100%	77.3%	0.856	100%	82.4%	0.856			***
Inventory	Quantity of oe	100%	81.4%	0.856	100%	81.4%	0.856	*		
	Quantity of non oe	100%	81.1%	0.856	100%	81.7%	0.856			***
	Product Variety of oe	100%	81.4%	0.857	100%	81.4%	0.856		**	
	Product Variety of non oe	100%	82.8%	0.858	100%	80.0%	0.854			***

[a] Base Value : order fill rate oe =100%, order fill rate non oe =81,4%, and COGS = 0,856