Dynamics of Scope

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***Abstract*– The purpose of this research is to present the evolution of economic and organizational change resulting from the demands imposed by the market needs of a company dedicated to the production of cement. The use of productive resources, the control and measurement of capital as a determining factor for the production of cement and the access to new types of related businesses, is the objective of this article. Its development was carried out through the identification of concepts such as: vertical organization, organization by processes, organization by people, causal diagram, flow chart and economy of scope. The research was carried out empirically by observing the activities developed within the process and interviewing its main actors, identifying through qualitative diagrams the cause-and-effect relationship of the independent and dependent variables, and analyzing through quantitative diagrams the impact of their behavior on the organization's economy. The results of the changes made validated that, an adaptive organization, which creates value with multidisciplinary teams, can reconfigure the operational activities for different types of business within an organization, generating profitability with an economy of scope greater than zero.**

Keywords; Economy, Variables, Economy of Scope, Dynamics, Causal Diagram and Quantitative Diagram.

I. Introduction (Heading 1)

This research was carried out in a company XXX, which produces concrete as the main product, and cement and aggregates as raw materials [1, 2, 3, 4]. The areas that produce these products are separate; they are independent. The objective of the Board of Directors is to empower each area, so that each of them has autonomy to make its own decisions in the organizational, administrative and economic management, in order to manage its contribution to the common interest. Coordination should be done by mutual adaptation through commitment and collaboration.

Specifically in this research we will refer to the organization that produces cement. It is structured vertically and the level of authority is directed from the top down, and the results must be presented from the bottom up. If we look at the macro level, it is distributed in administrative and operational areas.

The cement is distributed to five concrete factories, also known as ready-mix concrete plants, which are strategically distributed throughout the city for distribution and delivery to customers. The mixer should arrive to the client within 2.5 hours so that the concrete does not lose its homogeneity. Each ready-mix concrete plant has silos with 100-ton capacity for storing cement as a safety stock.

The capacity of the organization that produces type 1 Portland cement was initially oriented to distribute to ready-mix concrete plants. This area is considered in accounting terms as an external company that sells each ton of bulk cement distributed to the ready-mix concrete plants. The operating area began to increase its production capacity due to the market demand, surpassing the needs of the ready-mix concrete plants. In view of this situation and by decision of the board of directors, the remaining cement was to be sold in 42.5-kilogram bags and in 1,000-kilogram big bags, establishing two new types of business.

The organization's responsibilities included determining the price for each product, but this was not done in a technical-economic way; it was done through a survey of the prices of its main competitors. The gross and net profit of the company was only known at the end of the month when the accounting area presented the profit and loss statements.

The organization believed that selling in 42.5-kg bags and 1,000-kg big bags was not profitable. Their hypothesis was that adding more operational activities and acquiring bagging machines would increase the complexity and costs, such as workforce, maintenance and inputs for bagging the new products [5, 6, 7]. Making a small change was changing everything and the organization did not consider it as a good option. In addition, the organization could not respond preventively or quickly to the needs of customers when they requested these products in larger quantities; organizationally it was not prepared.

The board of directors understood that changes in business models open the possibility of innovating markets, products, value chain, and distribution channels [8, 9, 10]. Innovation in the business model makes it possible to create, in a more structural way, better products at a better price. That is productivity today; competitiveness tomorrow. They also understood that the experiences and recipes of the past are only a resource of enormous importance to face the current and future challenges of the company.

The organization did not understand that the acceleration of markets would increase year by year and this would destroy business models that had been successful in their time. Making it possible to design new ways of doing business was the organization's responsibility, but there were no shared values that favored experimentation and learning.

The organization was slow, bureaucratic and uncreative. Faced with this scenario, the board of directors began to search for a change within the organization to a more competitive model, and for this to be possible it would have to sacrifice sacred cows and change the way they operated, related and thought. In view of this, the board of directors considered that the organization that produced the cement should go through an organizational change, from a rigid model to an organization by person, for the economic health of the company.

A. Statement of the Problem

How to break the paradigm of an organization that has positioned the company among the best in the market?

What was the main driver of the change from a vertical organization to an organization by person?

What are the main factors that prevent the organization from becoming more adaptable?

How to develop an organizational strategy that generates participation, that listens to input and encourages a culture that values interconnection, that creates and nurtures it?

B. Objective

To show the degrees of adaptability of the organization in view of the increase in the types of business that arise due to the demands of market needs; the convergence between openness, the learning of the organization by its adaptability, the development of conceptual models, and its qualitative and quantitative analysis of the economic variables that allow to determine and validate the profitability by means of the economy of scope, due to the changes made.

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C. Hypothesis

Innovative companies continuously improve their business models, with an overall vision that ensures consistency between strategy and operations, as well as the needs of customers and employees. The variety of business models developed within an organization is not a limiting factor for the increase of its profitability, but a challenge for change, identifying the problem or limiting variables that affect not only the normal development of the organization but also its evolution to the changes demanded by the market.

II. METHODOLOGY

This research was conducted by using the empirical method, through observation and interview, collecting information on each activity that takes place within the cement manufacturing system, identifying the independent and dependent variables, analyzing their cause-and-effect relationship in a conceptual way, with the objective of gaining understanding of their dynamics within the system.

And, the quantitative method by using algorithms immersed in each variable to determine and analyze the degrees of behavior over time.

A. Vertical Organization: "This is how we do it here"

People in each area of the organization did not want to leave their "comfort zone"; they felt comfortable managing the status quo and there was weak communication between areas [11] to avoid involvement and conflicts. When faced with a request to change or modify an operational or administrative activity to reduce execution times, or to redeploy personnel to another area to be more productive, the common phrase heard was: "This is how we do it here. Why should we change? If this is still giving us positive results."

Due to the impossibility to generate changes because of the lack of adaptability of the personnel, those who knew the system and its performance in this type of structure were very efficient and effective, since they worked under pressure, but they were not very creative, since they only fulfilled their functions detailed in the organization and functions manual, and this did not help the company to adapt to new business models.

Decision-makers considered that if everything around us was changing as it was happening in the market, the only possible alternative was that our organizations would also be able to change rapidly. Before, we had to innovate to grow, now we have to innovate to survive. Faced with this situation, they began to make organizational changes.

B. From a Vertical Organization to an Organization by Processes

Decision-makers began to redesign the organizational chart by identifying the functions for each area, so that they would be as symmetrical as possible to help employees with intermediate level responsibilities to know who their peers are in the other functions. This encouraged communication and collaboration without having to climb higher up [12, 13, 14, 15].

Their goal was to drastically reduce the weight and strength of the organization's past, which brought them many benefits. They began to facilitate innovation and empower the renegades in each area (renegades are those people who always want to do something different) and disarm the so-called "passion killers". Faced with the changes made, people within the organization still did not feel the level of importance of the changes.

The production line was reorganized as follows: storage of raw materials (limestone, clinker and gypsum) to be transported by conveyor belts to the mill and, subsequently, to the silos to finish bagging, either of 42.5 or 1,000 kilograms, and to be directly dispatched by filling tanker trucks (also called bulk carriers).

And new operational processes were developed, including: purchasing, warehousing and dispatch. These areas must deploy resources more quickly to meet the changing volumes of each type of product (bulk cement, 42.5 kg cement bag and 1,000 kg cement big bag).

But the commitment of employees to change was still lacking. Any organizational innovation required changes in the way the organization worked in order to turn new ideas into reality. Thus, decision-makers focused on people, developing an organization by person.

C. From an Organization by Processes to an Organization by Person

Managers understood that decision-makers within the organization are a key element, since their daily practice and example show how much they value and what they expect from their collaborators. They began to promote a culture favorable to innovation by changing the way they manage and train personnel, since they considered that each person in the process has a role to play. They constitute the cultural base through their performance in work teams and communities of interest [16, 17]. Thus, decision makers had to foster human relationships between collaborators in each area and between areas to favor problem solving.

The executed objective for the organization was to create value through people [18, 19] by developing independent multidisciplinary teams and value-added work groups that act as responsible business units and independent profit centers.

People within the organization began to gain conceptual strength, focusing on elements that historically did poorly from an operational, administrative or consumer point of view. They developed qualitative scenario models (causality diagram), first in a conceptual way, analyzing the variables that are resources and products and how they interacted within the system from a cost-benefit point of view.

This brought positive results as they developed quantitative scenario models (flow charts) that allowed them to determine and simulate the costs and profit for each type of product, as well as to determine whether the business model applied is beneficial to the company by determining the economy of scope.

D. System Dynamics (SD)

System Dynamics is a methodology for the study and management of complex feedback systems, allowing the development of easily understandable scenario models to share knowledge of the system with others [20, 21, 22, 23, 24, 25, 26].

The characteristic of this discipline is the use of computer and Vensim as software for making qualitative and quantitative diagrams. Mathematical models give rise to first order equations, to the mathematical representation and algorithms within each variable exposed in the flow chart.

E. Qualitative Diagram

A causal diagram represents the influence relationships between the elements of a system and, therefore, provides insight into the structure of the system [27].

Figure 1 presents the causal diagram showing the key variables and their cause-and-effect relationships that influence the production and estimation of cement cost and profitability.

In the cement sector, the proposed model is composed of three cycles that consider the different variables such as: demand, production, productive resources, costs, income from sales and profit.

- In cycle (a), profit is determined by the income from sales, as a result of cement demand and production, i. e. the higher the production, the higher the income and, consequently, the higher the profit.

- In cycle (b), the higher the demand, the higher the cement production, and this will directly affect variable costs by increasing them, and an increase in fixed costs will increase production costs.

- In cycle (c), the behavior of variable costs is caused by the use of productive resources. The greater the use of workforce for the production of cement, the higher the costs; the longer the time of using the machine, the more wear and tear it will generate, increasing the cost of maintenance; and, the higher the cost of raw materials and inputs, such as clinker, gypsum, limestone and the additive, the higher the costs. And, as for the

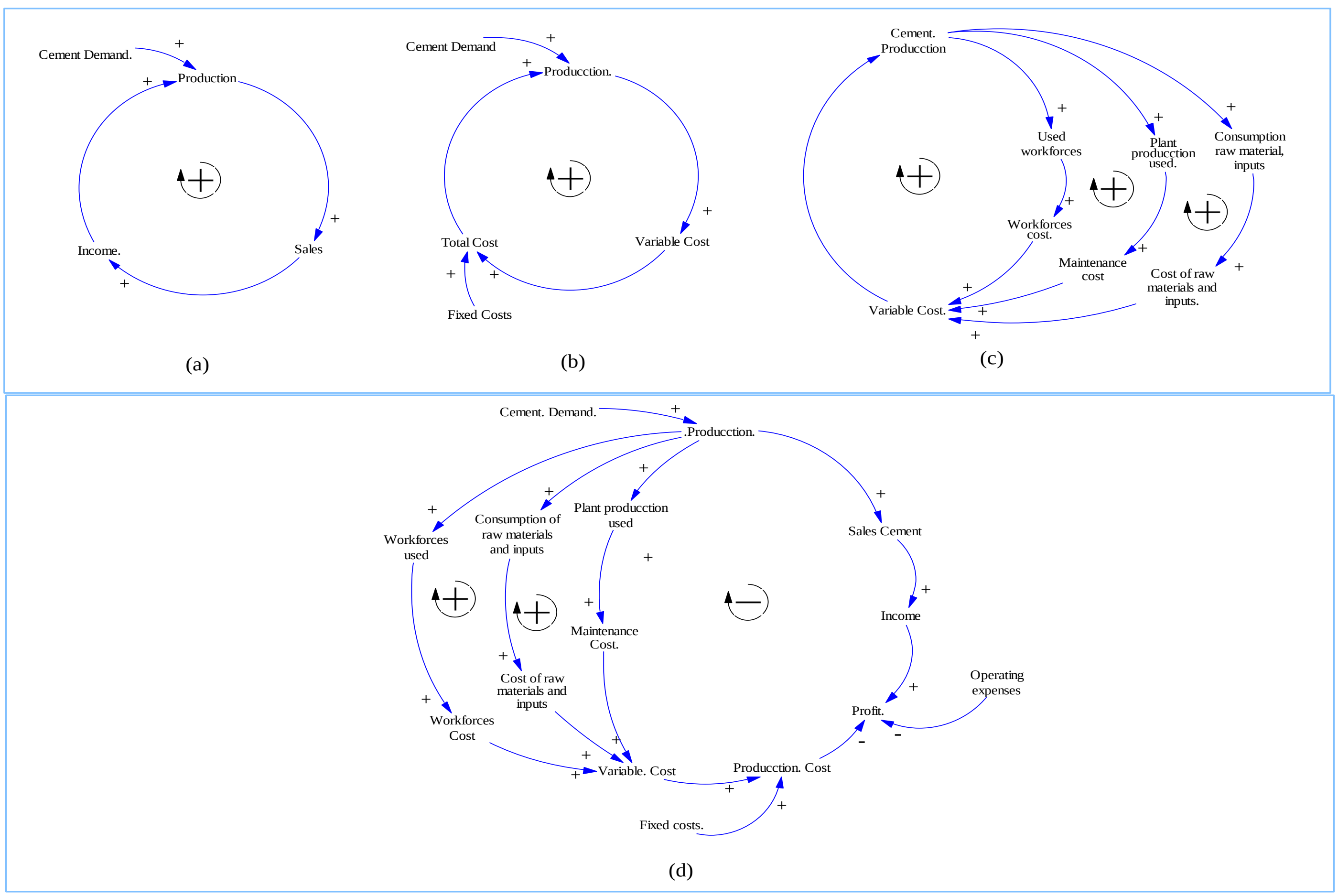

Figure 1. Causal Diagram

use of raw materials and inputs such as clinker, gypsum, limestone and additives, their increase will also increase variable costs.

- As a result of the increase in demand, production will increase and, as a consequence, the use of productive resources such as raw materials, inputs, workforce and time, will increase. As these productive resources vary according to the level of production, their variable costs will increase, as will the production costs, allowing the profit to increase proportionally to sales, as shown in cycle (d).

F. Flow Chart

The Flow Chart, also called Forrester Diagram, is a translation of the causal diagram, which allows writing by means of equations to validate the model, observe the behavior of the variables and perform sensitivity analysis [28, 29].

Figure 2 shows the scenario model where level, flow, auxiliary and parameter variables are identified. Level variables are those that define the behavior of bulk cement profits, bag cement profits, big bag cement profits and their stock. Flow variables directly affect the levels in each time unit, and auxiliary variables are intermediate dependent between variables and parameters. Parameters, as they are constants, can be modified to perform simulations and are identified in Figure 2 with the green text.

The number of variables and parameters exposed in the model are as follows:

- Level Variable = 2
- Flow Variable = 8
- Auxiliary Variable = 27
- Parameters = 30

G. Mathematical Model

For a better understanding of the flow chart, it was divided into five loops (Figure 2 (a)), showing the cause-and-effect relationship of each variable and detailing the equations present for each of them.

H. Variable Cost

Figure 03 shows the positive feedback loop. The variation of any element such as: unit consumption of raw material or input, unit price of raw material or input, cost of workforce, cost of maintenance and total order, determine an increase in

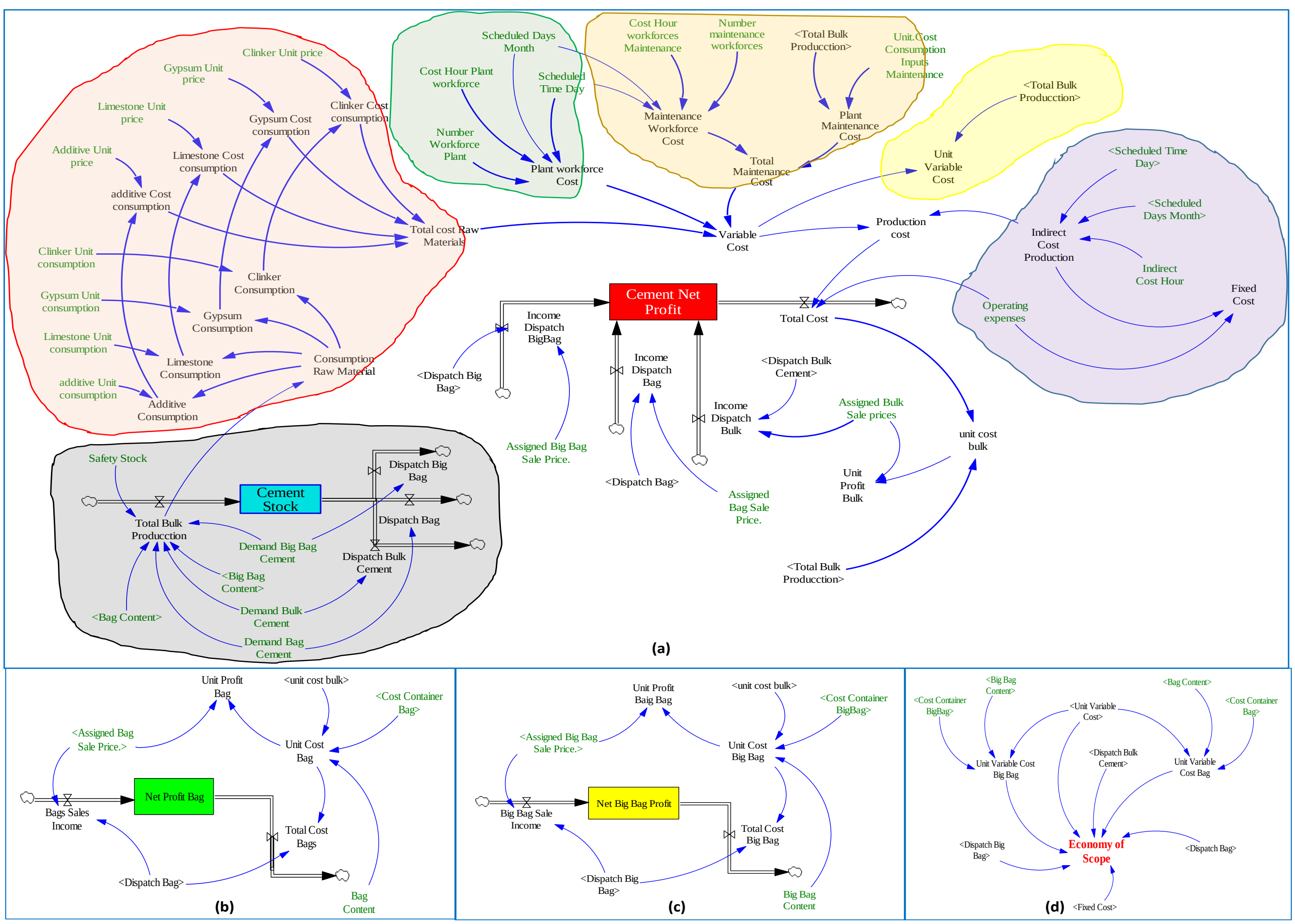

Figura 2. Flowchart

the variable cost system. In this type of structure, the cost has to increase or decrease without any limitation [30, 31, 32].

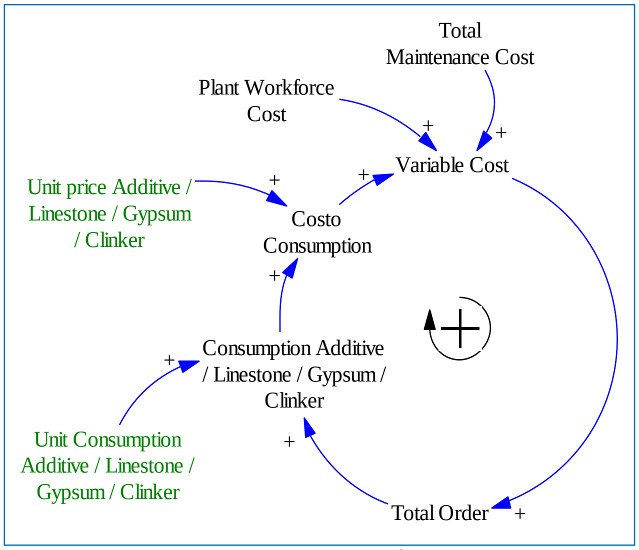

Figure 03. Flow Chart of Variable Costs

In order to introduce a dynamic hypothesis, it is assumed that the state represents the accumulation of past actions. It is further assumed that the relationship between the state Total Order and the action Variable Cost is given by the equation of the form:

$$\frac{dTotalBulkProduction}{dt} = VariableCost$$

$$\int_0^t \frac{dTotalBulkProduction}{VariableCost} = \int_0^t kdt$$

$$\ln VariableCost = kt + C$$

$$e^{\ln VariableCost} = e^{kt} e^{C}$$

$$e^{\ln VariableCost} = C\ e^{kt}$$

$$VariableCost = C\ e^{kt} \qquad (1.1)$$

$$VariableCost(0) = C\ e^{k(0)}$$

$$VariableCost(0) = C \qquad (1.2)$$

De (1.2) en (1.1)

$$VariableCost(t) = VariableCost(0) e^{kt} \qquad (1.3)$$

The other elements of the loop are given by the equations:

$$VariableCost = \text{Consumption}Cost + \text{PlantWorkforce}Cost + \text{TotalMantenance}Cost \qquad (1.4)$$

$$\text{Consumption}Cost = UnitPrice * RawMaterial \qquad (1.5)$$

$$\text{Consumption}RawMaterial = RawMaterialUnit * TotalBulkProduction \qquad (1.6)$$

By substituting equations (1.4), (1.5) and (1.6), into equation (1.3) we have:

$$VariableCost(t) = [(UnitPriceRawMaterial * \text{ConsumptionUnit}RawMaterial * TotalBulkProduction) + PlantWorkforceCost + TotalMaintenanceCost](0)\ e^{kt}$$

This equation allows us to represent the time evolution of the state, through the following graph.

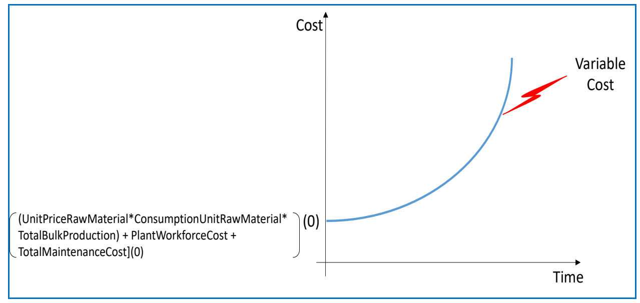

Figure 04: Behavior of Variable Cost

I. *Total Cost*

Figure 05 shows the positive feedback loop. The loop shows the disturbing elements such as: indirect costs, operating expenses and total order, which influence the increase or decrease of variable costs, production costs and total cost. The total cost is considered as a level variable and is represented by the following expression:

$$TotalCost(t + \Delta t) = TotalCost(t) + \Delta t(ProductionCost + OperatingExpenses)$$

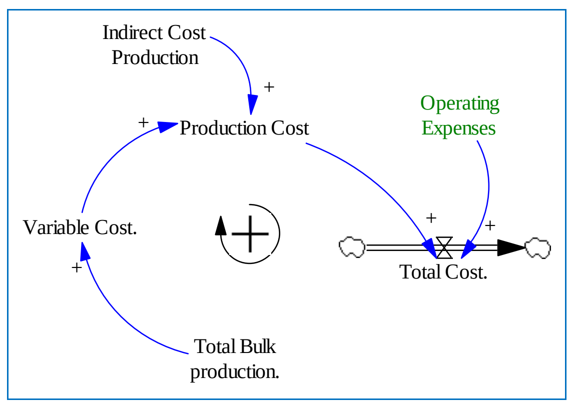

Figure 05. Flow Chart of Costs

The relationship between the Total Order state and the Total Cost, is given by the following equation:

$$\frac{dTotalBulkProduction}{dt} = TotalCost$$

$$\int_0^t \frac{dPTotalBulkProduction}{TotalCost} = \int_0^t kdt$$

$$\ln TotalCost = kt + C$$

$$e^{\ln TotalCost} = e^{kt} e^{C}$$

$$e^{\ln TotalCost} = C\ e^{kt}$$

$$TotalCost = C\ e^{kt} \qquad (2.1)$$

$$TotalCost(0) = C\, e^{k(0)}$$

$$TotalCost(0) = C \qquad (2.2)$$

(2.2) into (2.1)

$$TotalCost(t) = TotalCost(0)e^{kt} \qquad (2.3)$$

The other elements of the loop are given by the equations:

$$TotalCost = ProductionCost + OperatingExpenses \qquad (2.4)$$

$$ProductionCost = VariableCost + IndirectCostProduction \qquad (2.5)$$

By substituting equation (2.3) into equations (2.4) and (2.5), we have:

$$TotalCost(t) = [(VariableCost + IndirectCostProduction + OperatingExpenses)](0)\, e^{kt} \qquad (2.6)$$

This equation allows us to represent the time evolution of the state, through the following Figure 6.

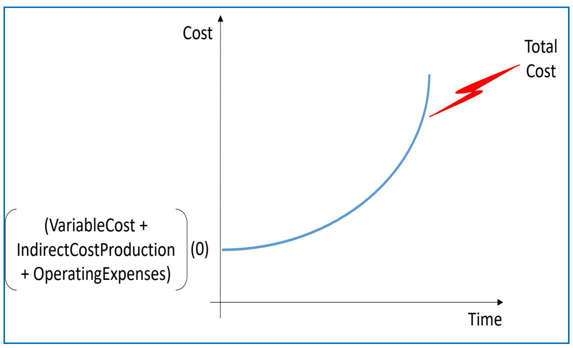

Figure 06: Cost behavior

J. Net Profit

Figure 07 shows the negative feedback loop, with the system being stable. The elements influencing the increase or decrease of the net profit are the income from the order and the price established, and the total cost. The net profit is considered as a level variable and is represented by the following equation:

$$CementNetProfit(t+\Delta t) = CementNetProfit(t) + \Delta t(Income - \mathrm{TotalCost})$$

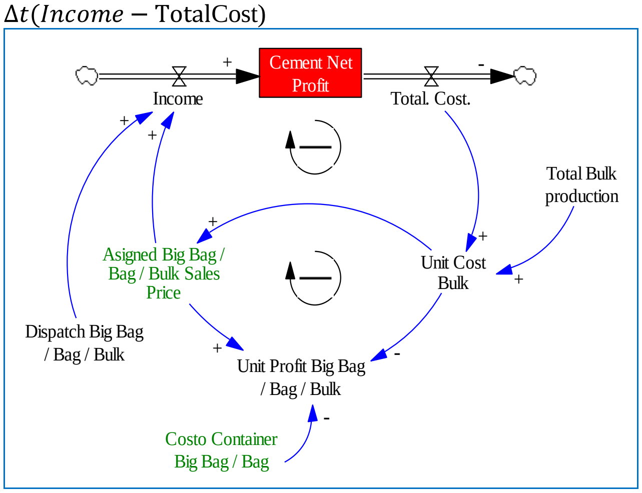

Figure 07: Flow Chart of Income, Costs and Profit from Sales of Bulk Cement

$$\frac{dCementNetProfit}{dt} = Income - \mathrm{TotalCost}$$

$$\int_0^t \frac{dCementNetProfit}{Income - \mathrm{TotalCost}} = \int_0^t kdt$$

$$\ln(Income - \mathrm{TotalCost}) = kt + C$$

$$e^{\ln(Income - \mathrm{TotalCost})} = e^{kt}e^{C}$$

$$e^{\ln(Income - \mathrm{TotalCost})} = C\, e^{kt}$$

$$(Income - \mathrm{TotalCost}) = C\, e^{kt} \qquad (3.1)$$

$$(Income - \mathrm{TotalCost})(0) = C\, e^{k(0)}$$

$$(Income - \mathrm{TotalCost})(0) = C \qquad (3.2)$$

$$(Income - \mathrm{TotalCost})(t) = (Income - \mathrm{TotalCost})(0)e^{kt} \qquad (3.3)$$

The other elements of the loop are given by the equations:

$$Income = Asigned\ Big\ Bag/\ Bag/\ Bulk\ Sales\ Prices * Dispatch\ Big\ Bag/\ Bag/\ Bulk \qquad (3.4)$$

By substituting equation (3.3) into equations (3.4) and (2.6) we have:

$$CementNetProfit(t) = Asigned\ Big\ Bag/\ Bag/\ Bulk\ Sales\ Prices * Dispatch\ Big\ Bag/\ Bag/\ Bulk - (\mathrm{VariableCost} + \mathrm{IndirectCostProduction} + \mathrm{OperatingExpenses})(0)e^{kt})$$

This equation allows us to represent the time evolution of the state, through the following chart.

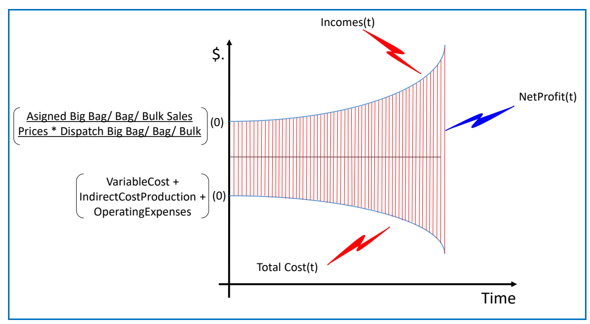

Figure 08: Behavior of Income, Costs and Profit from Sales of Bulk Cement

K. Stock

Figure 09 shows the negative feedback loop, with the system being stable, and the elements influencing the increase or decrease of the stock as a consequence of the total cement production and the dispatch made. The stock is considered as a level variable and is represented by the following equation:

$$CementStock(t+\Delta t) = CementStock(t) + \Delta t(\mathrm{TotalBulk}Production - \mathrm{Dispatch\ Big\ Bag/\ Bag/\ Bulk})$$

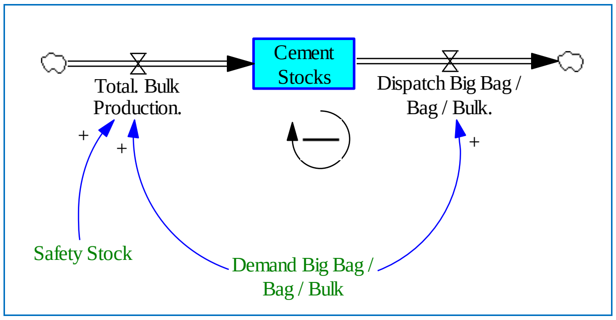

Figure 09: Flow chart of Production, Stock and Dispatch of Bulk Cement

$$\frac{dCementStock}{dt} = TotalBulkProduction - Dispatch\ Big\ Bag/\ Bag/\ Bulk$$

$$\int_0^t \frac{dCementStock}{TotalBulkProduction - Dispatch\ Big\ Bag/\ Bag/\ Bulk} = \int_0^t kdt$$

$$\ln(TotalBulkProduction - Dispatch\ Big\ Bag/\ Bag/\ Bulk) = kt + C$$

$$e^{\ln(TotalBulkProduction - Dispatch\ Big\ Bag/\ Bag/\ Bulk)} = e^{kt} e^{C}$$

$$e^{\ln(TotalBulkProduction - Dispatch\ Big\ Bag/\ Bag/\ Bulk)} = C\ e^{kt}$$

$$(TotalBulkProduction - Dispatch\ Big\ Bag/\ Bag/\ Bulk) = C\ e^{kt}$$

$$(TotalBulkProduction - Dispatch\ Big\ Bag/\ Bag/\ Bulk)(0) = C\ e^{k(0)} \quad (4.1)$$

$$(TotalBulkProduction - Dispatch\ Big\ Bag/\ Bag/\ Bulk)(0) = C \quad (4.2)$$

(4.2) into (4.1)

$$(TotalBulkProduction - Dispatch\ Big\ Bag/\ Bag/\ Bulk)(t) = (TotalBulkProduction - Dispatch\ Big\ Bag/\ Bag\ /\ Bulk)(0)e^{kt}$$

This equation allows us to represent the time evolution of the state, through the following graph.

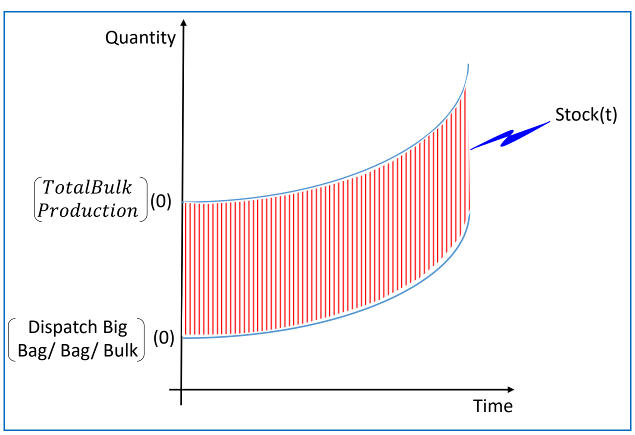

Figure 10: Stock Behavior

L. Bag Cement

Figure 11 shows the negative feedback loop, i.e. the system is stable. The elements that influence the increase or decrease of the net profit from the sale of cement bags are a consequence of sales income and the total cost of the production and packaging of this product. The net profit from the sale of cement bags is considered as a level variable and is represented by the following equation:

$$NetProfitBag(t + \Delta t) = NetProfitBag(t) + \Delta t(BagSalesIncome - \mathrm{TotalCostBags})$$

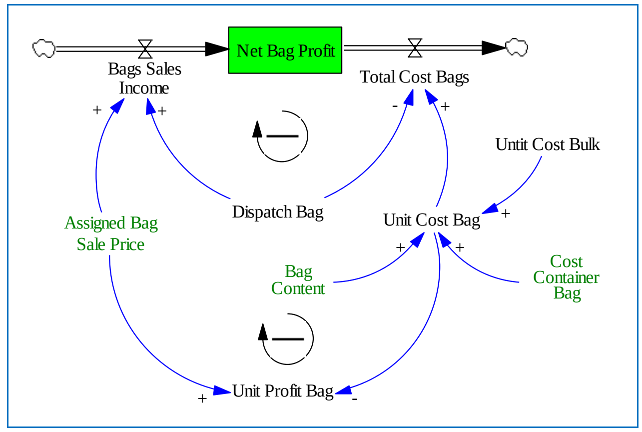

Figure 11: Flow chart of Income, Costs and Profit from Sales of Bag Cement

$$\frac{dNetProfitBag}{dt} = BagsSalesIncome - TotalCostBags$$

$$\int_0^t \frac{dNetProfitBag}{BagSalesIncome - TotalCostBags} = \int_0^t kdt$$

$$\ln(BagSalesIncome - TotalCostBags) = kt + C$$

$$e^{\ln(BagSalesIncome - TotalCostBags)} = e^{kt} e^{C}$$

$$e^{\ln(BagSalesIncome - TotalCostBags)} = C\ e^{kt}$$

$$(BagSalesIncome - TotalCostBags) = C\ e^{kt} \quad (5.1)$$

$$(BagSalesIncome - TotalCostBags)(0) = C\ e^{k(0)}$$

$$(BagSalesIncome - TotalCostBags)(0) = C \quad (5.2)$$

Equation (5.2) into equation (5.1)

$$(BagSalesIncome - TotalCostBags)(t) = (BagSalesIncome - TotalCostBags)(0)e^{kt} \quad (5.3)$$

The other elements of the loop are given by the equations:

$$BagSalesIncome = AssignedBagSalePrice * Dispatch\ Bag \quad (5.4)$$

Where; $Dispatch\ Bag = DemandBagCement$

$$TotalCostBags = UnitCostBag * Dispatch\ Bag \quad (5.5)$$

$$UnitCostBag = UnitCostBulk * GabContent + CostContanerBag \quad (5.6)$$

By substituting equation (5.3) into equations (5.4), (5.5), and (5.6) we have:

$$NetProfitBag(t) = (AssignedBagSalePrice * Dispatch\ Bag - UnitCostBag * Dispatch\ Bag)(0)\ e^{kt}$$

$$NetProfitBag(t) = (AssignedBagSalePrice * Dispatch\ Bag - (UnitCostBulk * GabContent + CostContanerBag) * Dispatch\ Bag)(0)\ e^{kt}$$

This equation allows us to represent the time evolution of the state, as shown in Figure 12.

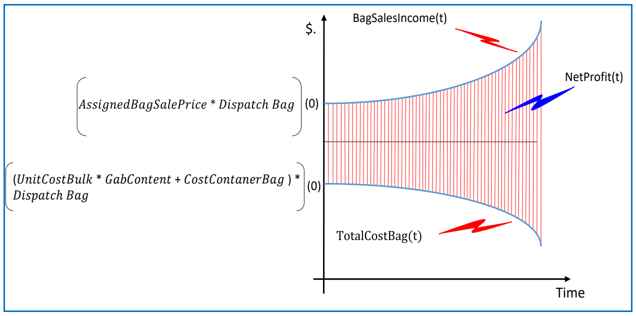

Figure 12: Behavior of Income, Costs and Profit from Sales of Bag Cement

M. Cement in Big Bag

Figure 13 shows the negative feedback loop, i.e. the system is stable. The elements influencing the increase or decrease of the net profit from the sale of cement in big bags are a consequence of sales income and the total cost of the production and packaging of this product. The net profit from the sale of cement in big bags is considered as a level variable and is represented by the following equation:

$$NetBigBagProfit(t + \Delta t) = NetBigBagProfit(t) + \Delta t(BigBagSalesIncome - TotalCostBigBag)$$

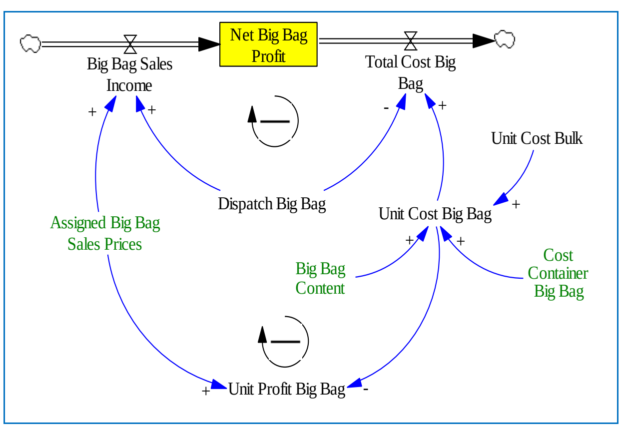

Figure 13: Flow chart of Income, Costs and Profit from Sales of Cement in big bag

$$\int_0^t \frac{dNetBigBagProfit}{BigBagSalesIncome - TotalCostBigBag} = \int_0^t kdt$$

$$\ln(BigBagSalesIncome - TotalCostBigBag) = kt + C$$

$$e^{\ln(BigBagSalesIncome - TotalCostBigBag)} = e^{kt} e^{C}$$

$$e^{\ln(BigBagSalesIncome - TotalCostBigBag)} = C\ e^{kt}$$

$$(BigBagSalesIncome - TotalCostBigBag) = C\ e^{kt} \quad (6.1)$$

$$(BigBagSalesIncome - TotalCostBigBag)(0) = C\ e^{k(0)}$$

$$(BigBagSalesIncome - TotalCostBigBag)(0) = C \quad (6.2)$$

Equation (6.2) into (6.1)

$$(BigBagSalesIncome - TotalCostBigBag)(t) = (BigBagSalesIncome - TotalCostBigBag)(0)e^{kt} \quad (6.3)$$

The other elements of the loop are given by the equations:

$$BigBagSalesIncome = AssignedBigBagSalePrice * DispatchBigBag \quad (6.4)$$

Where; $DespachoBigBag = \text{Demand Big Bag Cement}$

$$TotalCostBigBag = UnitCostBigBag * DispatchBigBag \quad (6.5)$$

$$UnitCostBigBag = UnitCostBulk * BigBagContent + CostContainerBigBag \quad (6.6)$$

By substituting equation (6.3) into equations (6.4), (6.5), (6.6), and (6.7) we have:

$$NetBigBagProfit(t) = [AssignedBigBagSalePrice * DispatchBigBag - (UnitCostBulk * BigBagContent + CostContainerBigBag) * DispatchBigBag](0)\ e^{kt}$$

By the next Figure 14. This equation allows us to represent the time evolution of the state, through the following figure 14.

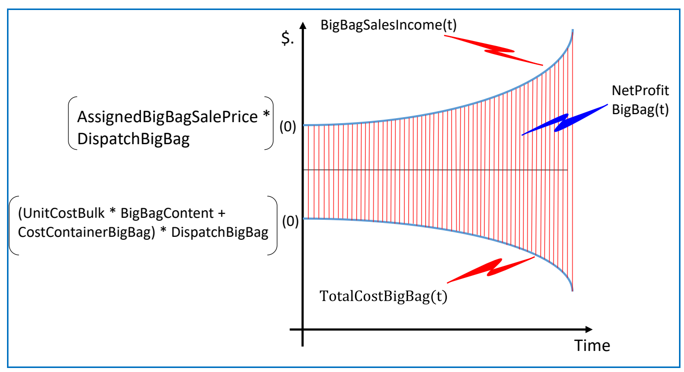

Figure 14: Behavior of Income, Costs and Profit from Sales of Cement in big bag

N. Economy of Scope

Figure 2 (a) shows the loop for determining the economy of scope and is represented by the following equation:

$$EconomyOfScope = \frac{FixedCost}{(FixedCost + TotalVariableCostBulk + TotalVariableCostBag + TotalVariableCostBigBag)}$$

Where;

$k = UnitVariableCost * DispatchBulkCement$

$TotalVariableCostBag = UnitVariableCostBag * DispatchBag$

$TotalVariableCostBigBag = UnitVariableCostBigBag * DispatchBigBag$

O. Identification of Parameters

The values of control variables to define the scenario model are as follows:

- Initial time = 0
- Final time = 12
- Passage of time = 1
- Time unit = month

Table 1.- Demand of bulk, bag and big gag cement per month

Month	Demand Bulk Cement	Demand Bag Cement	Demand Big Bag Cement
	ton cement/Month	bag/Month	big bag/Month
0	600	800	20
1	620	850	25
2	640	900	30
3	660	950	35
4	680	1000	40
5	700	1050	45
6	720	1100	50
7	740	1150	55
8	760	1200	60
9	780	1250	65
10	800	1300	70
11	820	1350	75
12	840	1400	80

Safety stock = 5%

Table 2.- Unit consumption of raw materials.

Input	Unity	Quantity
Clinker	Ton clinker/ton cement	0.9
Gypsum	Ton gypsum/ton cement	0.06
Limestone	Ton limestone/ton cement	0.04
Additive	Kilogram additive/ton cement	0.4

Table 3.- Unit purchase price of raw materials.

Input	Unity	Unit Price
Clinker	$/Ton clinker	16.5
Gypsum	$/Ton gypsum	8,75
Limestone	$/Ton limestone	6.45
Additive	$/Kilogram additive	0.75

Table 4.- Parameters or constants used to determine workforce costs.

Input	Unity	Quantity
Number Workforce Plant	Workforce	14
Cost Hour Plant workforce	$/(hour*workforce)	1.05
Scheduled Time Day	hour/day	10
Scheduled Days Month	day/Month	26

Table 5.- Parameters or constants used to determine total maintenance costs.

Input	Unity	Quantity
Number maintenance workforces	workforce	7
Cost Hour workforces Maintenance	$/(hour*workforce)	1.25
Scheduled Time Day	hour/day	10
Scheduled Days Month	day/Month	26
Unit.Cost Consumption Inputs Maintenance	$/ton cement	0.5

Table 6.- Parameters or constants used to determine the total cost.

Input	Unity	Quantity
Indirect Cost Hour	$/hour	45
Operating expenses	$/Month	10,000
Scheduled Time Day	hour/day	10
Scheduled Days Month	day/Month	26

Table 7.- Parameters or constants used to determine income from sales of bulk, bag and big bag cement.

Input	Unity	Quantity
Assigned Bulk Sale prices	$/ton cement	55.5
Assigned Bag Sale Price	$/bag	4.45
Assigned Big Bag Sale Price	$/big bag	59.5

Table 8.- Parameters or constants used to determine the net income from the sale of bag cement.

Input	Unity	Quantity
Cost Container Bag	$/ bag	0.06
Bag Content	ton cement/ bag	45/1000
Assigned Bag Sale Price	$/bag	4.45

Table 9.- Parameters or constants used to determine net profit from the sale of big bag cement.

Input	Unity	Quantity
Cost Container Big Bag	$/big bag	2.28
Big Bag Content	ton cement/big bag	1
Assigned Big Bag Sale Price	$/big bag	59.5

Table 10.- Parameters or constants used to determine economy of scope.

Input	Unity	Quantity
Cost Container Big Bag	$/big bag	2.28
Big Bag Content	ton cement/big bag	1
Cost Container Bag	$/bag	0.06
Bag Content	ton cement/bag	42.5/1000

III. RESULTS

Figure 15 shows the behavior with an increasing trend for each period due to the income from the sale of: bulk cement by 3%, bag cement by 5% and big bag cement by 10.8%. The fixed costs of $ 21,700 remain constant for each period and variable costs show a 3% increase, starting in the first period with $ 17,382 and reaching $ 22,998 in the 12th period with a loss in the first period of $ 1031.54. As sales income increases, the profit at the end of the period showed an accumulated profit of $ 64,311.4.

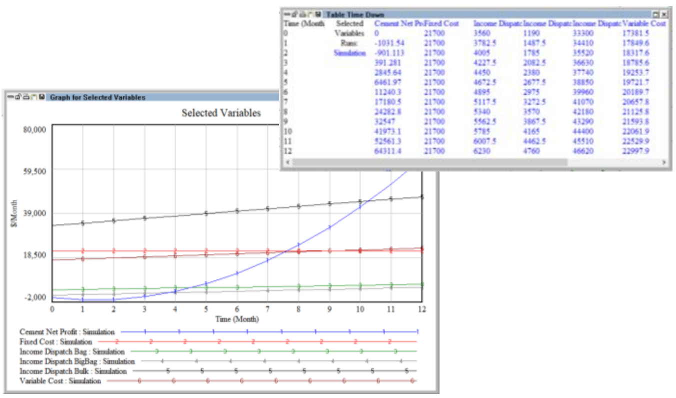

Figure 15: Behavior of Costs, Income and Profit for the production of bulk cement.

Figure 16 shows the cumulative increase in profit reaching $29,646 at the end of the period, due to an average monthly sales income of $4,895 with an average monthly cost of $2,341.

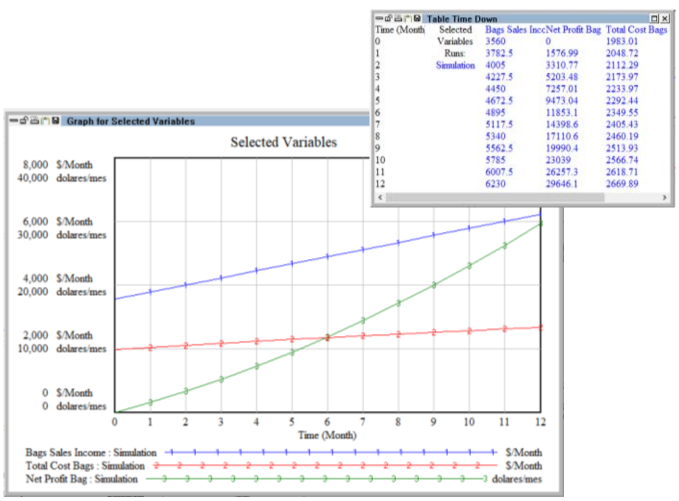

Figure 16: Behavior of Costs and Profit from the sale of cement bags.

Figure 17 shows the cumulative increase in profit reaching $5,015 at the end of the period for an average monthly sales income of $2,975 with an average monthly cost of $2,505.

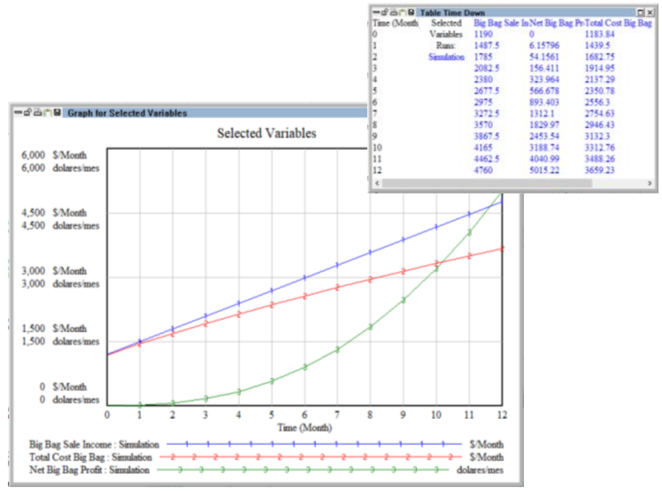

Figure 17: Behavior of Costs and Profit from the sale of cement big bags.

As variable costs tend to go up, as a result of the increase in the use of inputs, workforce and maintenance, with a constant fixed cost, the economy of scope factor tends to be greater than zero, as shown in Figure 18.

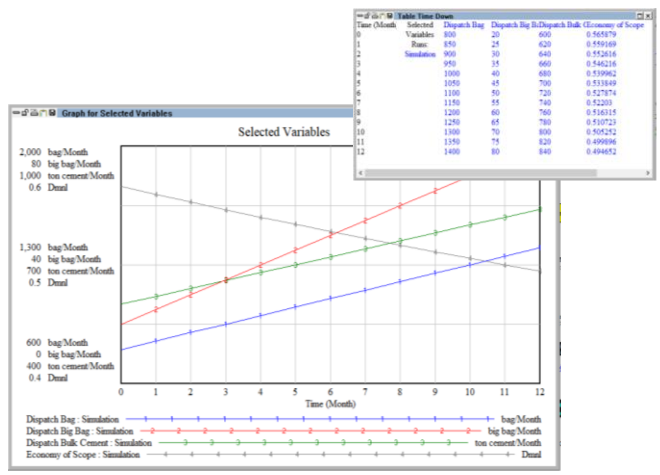

Figure 18: Behavior of the Economy of Scope.

DISCUSSION

The scenario models developed provide us with macro information of all the variables, i.e. the productive resources that are used for this type of manufacturing process. In each one of them, constant information or parameters and algorithms are entered which allow us to determine the levels of behavior of flow and level variables.

Having a macro visualization of all the variables in a single scenario model allows us to analyze, evaluate and control the cause and effect of each one of them effectively and this is what decision makers need.

If we compare this methodology of cost determination by means of a scenario model with the cost structure developed by Yu [33], Tramontin [34], Liu [35], Gabel [36], its presentation differs because they present a quantitative cost analysis in tables and through behavioral graphs, but they do not present an analysis of the interaction between the variables that affect cost determination.

The result of the costs, considering a price assigned by the decision maker, may vary over time due to external factors (political, economic, sociological, technological, ecological and legal), or internal factors (substitute products, the power of customers, the power of suppliers, rivalry among competitors, and new competitors), and their results show the profitability in each period.

The company under study also produces concrete and crushed stone. Developing a global study of the three processes in a single scenario will allow decision makers in this sector to have an overall control of costs, prices and profits for each volume produced in each process.

V. CONCLUSIONS

The board of directors defined and managed change in a structured way, aimed at delivering clearly defined results. Change management became firmly established as a core competency and professional discipline at all levels of the organization.

The organization understood that the innovations made in the company have been a long journey with increasing achievements based on the work and constancy of individuals and groups; that the success of the change was also due to data analysis and this depended on the capabilities of the people within the organization who had to effectively manage the analytical talent, i.e. qualitative and quantitative analysis, and information modeling techniques to configure new scenarios and make effective decisions.

The application of system dynamics has allowed the development of diagrams, identifying the independent and dependent variables involved in the cement production process, analyzing and evaluating each one of them, their relationship and interaction. This allows the decision-maker to determine the costs for each sales unit and to carry out simulations, modifying the independent variables with data that approximate the real situation, with the objective of determining the impact of costs and profit per period with respect to each type of sale.

REFERENCES

[1] N. Campoy, O. Chavez, E. Rojas, J. Gaxiola, J. Milla, D. De la Rosa, "Stress-strain analysis of concrete reinforced with metal and polymer fibers", *Ingeniería Investigación y Tecnología*, volume XXII, No 1, January-March 2021, p. 2.

[2] D. Guzman, J. Hernandez, T. Lopez, J. Horta, D. Giraldo, "Use of recycled asphalt pavement aggregate for a rigid pavement", *Ingeniería Investigación y Tecnología*, volume XXII No 1, January-March 2021, p. 3.

[3] A. Cardoso, I Guerreiro, M. Pina, R, Alves, "Influence of recycled concrete aggregates on the shear strength of reinforced concrete beams", *Rev. IBRACON Estrut. Mater*., vol. 14, no. 1, e14109, 2021, p. 2.

[4] S. Muthu, V. Govindasamy, A. Bari, "Experimental investigation on flexural performance of functionally graded concrete beams using flyash and red mud", *revista Matéria*, v.26, n.1, 2021, p. 3.

[5] S, Sinforoso, A. Pelegrin, E. Alvarez, "Contribution of Sustainable Cost to Water Care: An Outlook from the 2030 Agenda", *Retos de la Dirección* 2020; 14(2): 205-224 p. 208.

[6] K. Hurtado, "Cost systems, reverse logistics and sustainable management in industrial enterprises", *COODES 2020*, Vol. 8 No. 3 (September-December), p. 528.

[7] S. Martinez, J. Ricardez, A. Pelegrin, "Cost Approach of Environmental Externalities for Decision-Making in Environmental Matters; a Coffee Company Case", *Retos de la Dirección 2019*; 13(1):170-187, p. 173.

[8] E. Carballo, M. Betancourt, E. Craballo, "Innovation of Touristic Products in Resorts, A Procedure Based on Complex Adaptative Systems", *Retos de la Dirección 2021*; 15(1): 1-26, p. 3.

[9] I. Quintero, Y. Ospina, D. Quiroga, R. Cubillos, "Relationship between Innovation Capacity and the Innovation Index in Latin America", *J. Technol. Manag. Innov*. 2021. Volume 16, Issue 3, p. 48.

[10] V. Higuera, D. Cardona, H. Lora, "Monitoring, production goals, and incentives in manufacturing companies and their innovation results", *Información Tecnológica*, Vol. 32 Nº 6, 2021, p. 38.

[11] H. Charry, "The Management Of Internal Communication And The Organizational Climate In The Sector Public", *Comuni@cción* V.9, N.1, JAN-JUN, 2018, p. 26.

[12] Y. Olivera, L. Leyva, A. Napan, "Organizational climate and its influence on the work performance of workers", *Revista Científica de la UCSA*, Vol.8 No 2 August, 2021: 3-12, p. 4.

[13] A. Tamara, G. Villegas, "Influence of the financial environment, the macroeconomic environment, the organizational structure and transparency in business bankruptcy", *Contaduría y Administración* 66(2), 2021, 1-23, p. 4.

[14] D. Romero, V. Pertuz, E. Orozco, "Determining factors of competitiveness and organizational integration: scoping review", *Información Tecnológica* – Vol. 31 Nº 5 – 2020, p. 22.

[15] L. Totonelli, "Considerations On The Formalization Of Organizational Behavior", *Ciencias Administrativas, Revista Digital*, Year 6, N° 12 July - December 2018, p. 88.

[16] S. Abdollahzadeh, H. Manzari, S. Salajegheh, A. Sheikhi, "Creation of a strong bond between decision making styles of managers and organization structure through succession planning: a desirable model", *Revista Conrado*, 16(73), 442-448, p. 443.

[17] R. Taipe, "Organizational design through a systemic and cybernetic approach: The case of an enterprise of sanitation", *Ingeniare. Revista chilena de ingeniería*, vol. 28 Nº 1, 2020, p. 69.

[18] M. Diaz, "Preliminary Study about Organizational Development and Planed Change in an Organization of the Services Sector", *UH* No.288, La Habana jul.-dec. 2019 Epub 01-Sep-2019, p. 248.

[19] V. Rodriguez, K. Carbajal, N. Montenegro, "Work Resources as Predictors of Attitude Towards Organizational Change and Job WellBeing", *Revista de Psicología* 2018, 27(1), 1-13 p. 3.

[20] J. Delgado, "Dynamic model of COVID19 pandemic", *Sanid. mil.* 2021; 77 (1): 7-16, p. 9.

[21] N. Fuentes, S. Martinez, "Dynamic input-output model for a small economy", *Revista Latinoamericana de Economía*, vol. 52, issue 204, January-March 2021, p. 143.

[22] L. Da Silva, S. Barbalho, R. Augusto, "A bibliometric-qualitative study about the use of System Dynamics in the areas of Project and Program Management", *Gestão & Produção*, 28(4), e5770, 2021 p. 2.

[23] J. Ramirez, A. Garcia, “The Complicated Pairing Between Dynamic Systems Techniques And Economics”, *IE*, 79(314), October-December 2020, p. 30.

[24] M. Flores, D. Flores, B. Meneses, “Dynamics of Organizational Change”, *International Journal of Advanced Computer Science and Applications*, Vol. 11, No. 10, 2020,.p. 484.

[25] K. Perez, D. Ibarra, M. Ballen, “Modelling biodiesel production from microalgae, using industrial wastewater as a growth medium”, *Revista chilena de ingeniería,* vol. 28 Nº 4, 2020, pp. 744-754, p. 746.

[26] J. Diaz, E. Guerra, H. Neira, J. Garcia, L. Londoño, A. Valle, “Analysis of system dynamics in Vensim software”, *Revista Espacios* Vol. 40 (Nº 38) Year 2019, p. 20.

[27] W. Bonela, G. Mattos, “System Dynamics for Sustainable Transportation Policies: A Systematic Literature Review”, *Revista Brasileira de Gestão Urbana*, 2021, 13, e20200259, p. 2.

[28] N. Fuentes, S. Martinez, “Dynamic input-output model for a small economy”, *Revista Latinoamericana de Economía*, vol. 52, issue 204, January-March 2021, p. 147.

[29] L. Rodriguez, J. Loyo, M. Lopez, J. Vicente, “Dynamic simulation of a back-feeded production system”, *Ingeniería Industrial* Vol. XL, No. 2/may-august, 2019, p. 174.

[30] E. Guevara, D. Perez, et al. “The annual cost of medical care for patients with moderate to severe atopic dermatitis in Mexico”. *A multicenter study, Rev Alerg Mex.* 2020;67(1):9-18, p. 11.

[31] F. Bautista, E. Reyes, “Production Costs Effect on the Orange Market in Veracruz, 1980-2018”, *Región y Sociedad /* year 32 / 2020 / e1294, p. 4.

[32] L. Mestra, A. Martinez, M. Santana, “Technical and economic characterization of lamb meat production in Cordoba, Colombia”, *Agron. Mesoam*. 30(3):871-884, September-December, 2019, p. 875.

[33] J. Yu, L. Lin, J. Qian, X. Jia, F. Wang, “Preparation and properties of a low-cost magnesium phosphate cement with the industrial by-products boron muds”, *Construction and Building Materials* 302 (2021) 124400, p. 3.

[34] M. Tramontin, L. Onghero, B. Nunes, M. Angelica, A. Miranda, W. Longuini, F. Raupp, A. Novaes, “Novel low-cost shrinkage-compensating admixture for ordinary Portland cement”, *Construction and Building Materials* 230 (2020) 117024, p. 9.

[35] X. Liu, Z. Yuan, Y. Xu, S. Jiang, “Greening cement in China: A cost-effective roadmap”, *Applied Energy* 189 (2017) 233–244, p. 242.

[36] K. Gabel, P. Forsberg, A. Tillman, “The design and building of a life cycle-based process model for simulating environmental performance, product performance and cost in cement manufacturing”, *Journal of Cleaner Production* 12 (2004) 77–93, p. 90.