Journal of Multidisciplinary Engineering Science Studies (JMESS)
ISSN: 2458-925X
Vol. 3 Issue 5, May - 2017

Development Of A Supply Chain Model Integrating The Loss Function To Evaluate The Economic Loss In The Fulfillment Of The Goals. Insights From A Study Case

Héctor Gandhi Flores Saldivar
Master Degree Student
Departamento de Estudios Multidisciplinarios
Sede Yuriria, Universidad de Guanajuato
Yuriria, México.
hg.floressaldivar@ugto.com.mx

Roberto Baeza Serrato
Research Profesor
Departamento de Estudios Multidisciplinarios
Sede Yuriria, Universidad de Guanajuato
Yuriria, México.
r.baeza@ugto.com.mx

Rocío Alfonsina Lizárraga Morales
Research Profesor
Departamento de Estudios Multidisciplinarios
Sede Yuriria, Universidad de Guanajuato
Yuriria, México
ra.lizarragamorales@ugto.mx

Delia María Borda Fuentes
Master Degree Student
Departamento de Estudios Multidisciplinarios
Sede Yuriria, Universidad de Guanajuato
Yuriria, México
delia.borda@ugto.mx

***Abstract*— The present research article presents the evaluation of the characteristics of the perfect order; time, quantity and form of a supplier in a supply chain. In that the balanced loops and the loss function tool are integrated to monitor the fulfillment of the supplier's goals. The integration of this tool allows evaluating the economic loss by means of an indicator for not reaching the objectives. The calculation of the loss function is possible due to the Stella tool that allows the import and export of data to excel. The data that are exported to excel are the records that are generated in each characteristic until reaching the goal and the imported ones are the individual loss function values of each of the exported data. The contribution of this work is the evaluation of the perfect order; time, quantity and form; of an any member of the supply chain by integrating a quality engineering tool into the dynamic system model. The simulation model was implemented and validated in an invitation card manufacturing company in the city of Tunja, Colombia.**

Keywords—component; : Loss Function, supply chain, balanced loops, system dynamics.

I. INTRODUCTION

Over the course of history supply chains have emerged to meet the diverse needs of human societies, to exploit natural resources and to enable humans to engage profitably in commerce and trade [1]. The supply chain performance and effective management of supply chain have been increasingly recognized as critical factors in enhancing bottom-line performances [2], that is why it arises the need to evaluate the elements that make up the supply chain.

System dynamics is a perspective and set of conceptual tools that enable us to understand the structure and dynamics of complex systems [3]. The Taguchi loss function was developed by Genichi Taguchi as an aid to improving the implementation of total quality control in Japanese, Taguchi defines quality in a negative manner as “the loss imparted to society from the time the product is shipped”, and this “loss” includes the cost of customer dissatisfaction that leads to loss of company reputation [4].

In the present work a model is developed under the approach of the system dynamics methodology that allows to evaluate the economic loss through the function of loss, the characteristics to evaluate are of nominal type is better and will be the form, time and quantity of each member of the supply chain. The present paper is organized as follows: in the first section, the literature review is presented; in the second section, the development of the methodology with the proposed approach is displayed; the results are shown in the penultimate section, and, finally the conclusions are presented.

II. LITERATURE REVIEW

In the literature there are several works where the supply chain has been evaluated through various tools and methodologies. Reference [5] developed a model integrating the analytical hierarchy process that helps determine the importance of the risks and benefits of choosing a provider and the loss function that allows evaluating the performance of each provider to help support the selection decision of a provider. Other investigations that integrate the function of loss and the chain of supplies, in [6] they developed a tool so that the decision makers could have more information when hiring and selecting suppliers, the method used to evaluate was the function of Taguchi loss, to include non-tangible factors, these factors are Impact on the selection of the personnel, they produced a table to give weight to the qualifications obtained from the developed tool.

Reference [7] integrated three tools including simulation, Taguchi method and data envelopment analysis (DEA) approach to use efficiently the advantages of them simultaneously. Reference [8] carried out an investigation of the logistics of third parties, where all the relevant decision variables are identified through a scientific process known as QFD. The loss function provides a method for quantifying vendor performance in a single unit, allowing managers to make faster decisions.

Unlike the papers presented in the literature review, where they focus on evaluating certain characteristics of the supply chain using the loss function tool, in the present work, excel is integrated into the Stella simulation software, Stella have some characteristics that allows the link with Excel to export and import data and thus determine the economic loss of the three main characteristics of the elements of the supply chain.

The integration of the system dynamics methodology in the development of a supply chain has also been the object of study, in [9] developed a game called Mortage Service Game (MSG) under the system dynamics approach that allows simulating a chain of supplies, where each participant takes a role within the chain and helps him to better understand the repercussions of the decisions made.

Reference [10] conducted a study of systems dynamics and the supply chain applied in a poultry industry in Bangladesh, initially a causal diagram is proposed that is transformed into a stock and flow diagram for the model simulation. The results indicate that the supply chain contributes economic, social and environmental sustainability along with a structured production process.

Reference [11] explored the dynamics of the supply chain in relation to sustainable product programs and develops a framework for the supply chain to bring sustainable products to market. An empirical study is done on 28 European and American companies. The study identifies six dimensions of product sustainability, allowing managers to design programs for sustainable products, reduce costs and predict behavior with the introduction of them.

Reference [12] proposed a systems dynamics approach to model the total cost of supply chain (TSCC) in a grain chain in India, in order to predict the outcome in different situations and to develop policies for Reduce costs, there are nine scenarios for three activities: cooperative supply chain, contract agriculture and collaborative supply chain, based on optimistic, pessimistic and likely scenarios. Finally, it is proposed to reduce some intermediate measures for the reduction of costs between the final consumer and the farmer.

Reference [13] used the system dynamics methodology as a tool to evaluate the supply chain of an organization, considering the relationships between the different variables that involve the system, the study suggests that a company should increase its cooperative strength to be able to serve customers when there are large orders, in order to reduce the chances that customers will go with another supplier.

In the previous works they evaluate the supply chain as a whole; this work focuses on the fulfillment of the goals of the different main characteristics: quantity, time and form of each of the elements of the supply chain through the use of balanced loops.

III. METHODOLOGY

Fig. 1 shows the methodology to carry out the evaluation of the members of a supply chain, the work is supported by a theoretical framework and a literature review of the methodologies and tools that are used, the proposed approach consists of the integration the loss function to the system dynamics methodology, in the simulation model we use balanced loops to meet the goals of the main characteristics of the members of the supply chain, each of the main characteristics were evaluated as nominal characteristics is best in the loss function, integration of the loss function is possible because the Stella simulation software allows a link with Excel, which makes possible the import and export of data, in Excel we will calculate the loss function with the data generated from the stock variables, after the calculation of the individual and total loss function, we will export the data back to Stella to a variable of graphic function where we will perform the graph of the loss function to compare it with the curve of fulfillment of the goal.

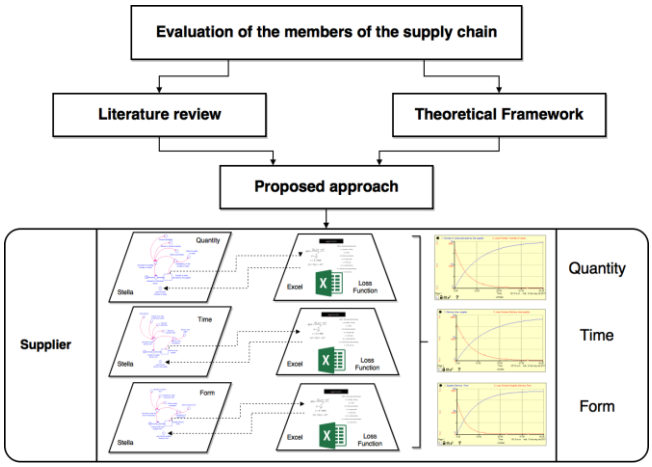

Fig. 1. *Proposed approach*

A. Development causal loop diagram

The causal diagram of the supplier system is shown in Fig. 2. In the diagram we can see that the variables product packaging, review of product quantity and stock confirmation affect positively the variable to increase the number of cards, the latter variable has a positive relation with the variable of increase of cards delivered. The increase in the number of cards delivered by the supplier creates a decrease in the variable of the discrepancy number of cards.

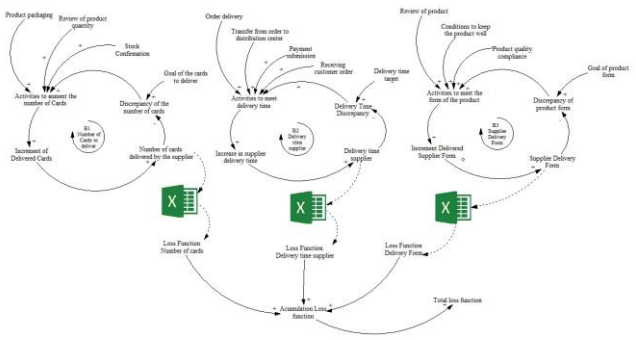

Fig. 2. *Causal Loop Diagram*

The diagram shows in variables the necessary corrective activities for the fulfillment of the target variables of the different characteristics for the supplier of a supply chain. The registers that are accumulating in the variable number of cards delivered to the provider are exported to excel to perform the calculation of the individual and total loss function after that, the data is imported from Excel to the variable Loss function number of cards to be able to realize the graph of the function of loss and to compare it with the accomplishment of goals. The loss function number of cards, loss function delivery time supplier and loss function delivery form variables has a positive effect on the total loss function variable.

B. Stock and Flow Diagram

The stock and flow diagram of the supplier is shown in Fig. 3 the system is composed of four stock variables that are identified with a rectangular shape are accumulation variables, four flow variables that allow changes in the levels of the stock variables and twenty-two auxiliary variables are represented by a circular shape and help to explain the system better. It is also possible to identify three balanced loops, each of which represents the fulfillment of the goals some of the main characteristics of the perfect order to evaluate any member of the supply chain.

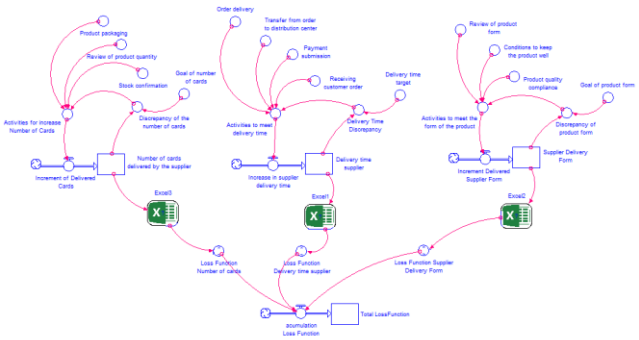

Fig. 3. *Stock and Flow Diagram*

IV. RESULTS

In Fig. 4, 5, 6 and 7, we can see the individual behavior of the represented loss with a red line and the fulfillment of the goals represented with a blue curve. Figure 4 shows the behavior of the Quantity feature where it can be observed that due to the balanced loop the characteristic is achieving its goal of 30 units and the loss function that has an initial value of 2100 Colombian pesos is having a decrease almost reaching zero.

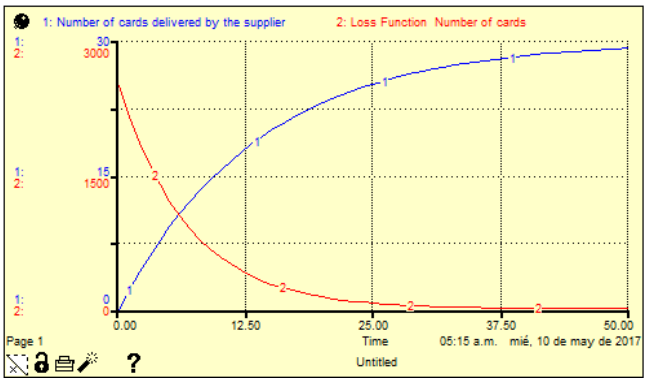

Fig. 4. *Behavior of the Quantity characteristic*

Fig. 5 shows the time characteristic that is directed to 48 hours, and its loss function value that initially is 1600 Colombian pesos is having a considerable decrease. In Figure 6 we can observe the behavior of the form characteristic so that because it is achieving its goal in a faster way its value of loss function that initially is 3500 Colombian pesos has a drastic decrease that makes the loss is lower for this characteristic in comparison with the other two characteristics.

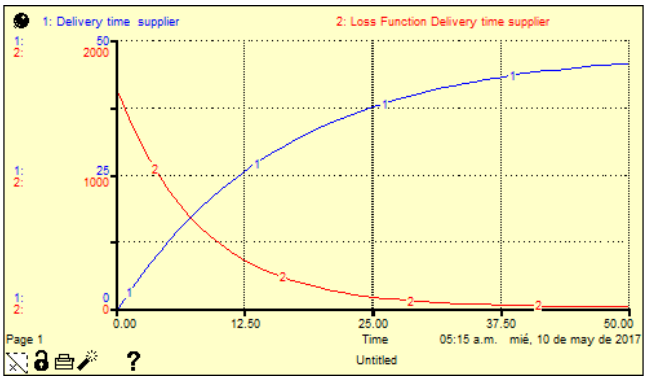

Fig. 5. *Behavior of the Time characteristic*

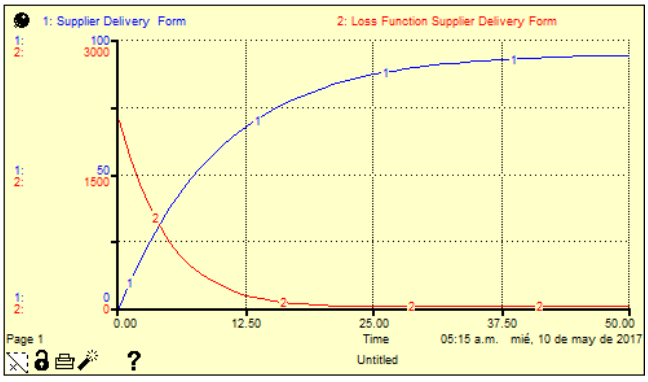

Fig. 6. *Behavior of the Form characteristic*

Interpretation of the graph of the total loss function, in Fig. 7 we can see the result of the accumulation of economic loss of the three characteristics quantity, time and form, which were evaluated as characteristics of nominal type is better, how Were evaluated as an individual behavior of each of them of descending type

and the accumulation of all generated a behavior of type looking for goals.

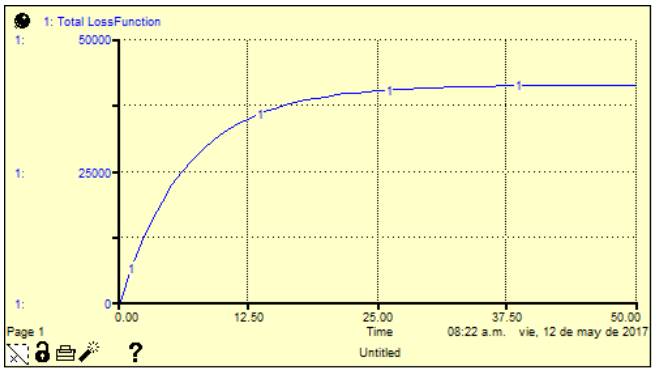

Fig. 7. *Behavior of the Total Loss*

V. CONCLUSIONS

The approach used in our research shows the possibility of evaluating the fulfillment of each of the characteristics of the elements of the supply chain from an economic approach, through the integration of the loss function with the system dynamics methodology, this in order to strengthen decision-making and identify strategies to reduce economic losses. With the methodology used in the present investigation the other elements of the supply chain can also be evaluated.

The integration of the loss function in the present project is largely due to the functionalities of the Stella software, since with the versatility of importing and exporting the data to Excel, it was possible to perform the calculation of the loss function, perform the graph of the loss function and carry out the comparison with the chart of achievement of goals. It also shows the importance of balanced loops to achieve the goals of different characteristics. It is proposed for future research to develop the loss function in the same Stella platform for different types of quality characteristics.

REFERENCES

[1] B. L. Maccarthy, C. Blome, J. Olhager, J. S. Srai, X. Zhao, and B. L. Maccarthy, “Supply chain evolution – theory , concepts and science,” Int. J. Oper. Prod. Manag., vol. 36, no. 12, pp. 1696–1718, 2016.

[2] R. Gawankar, Shrada; Kamble, Sachin; Raut, “Development, measurement and validation of supply chain performance measurement (SCPM) scale in Indian retail sector,” An Int. J., vol. 23, no. 1, pp. 25–60, 2016.

[3] J. D. Sterman, Business dynamics: Systems thinking and modeling for a complex world. 2000.

[4] T. Lofthouse, “The Taguchi loss function,” Work study, vol. 48, no. 6, pp. 218–222, 1999.

[5] S. M. Ordoobadi, “Application of AHP and Taguchi loss functions in supply chain,” Ind. Manag. Data Syst., vol. 110, no. 8, pp. 1251–1269, 2010.

[6] S. Ordoobadi, “Application of Taguchi loss functions for supplier selection,” Supply Chain Manag. An Int. J., vol. 1, pp. 22–30, 2009.

[7] N. Azadeh, Ali; Zarrin, Mansour; Salehi, “Supplier selection in closed loop supply chain by an integrated simulation- Taguchi-DEA approach,” J. Enterp. Inf. Manag., vol. 29, no. 3, 2016.

[8] S. K. S. K. V. Sharma, “Optimal selection of third-party logistics service providers using quality function deployment and Taguchi loss function,” Benchmarking An Int. J., vol. 22, no. 7, pp. 1281–1300, 2015.

[9] E. G. A. Jr, “A SIMULATION GAME FOR TEACHING SERVICE- ORIENTED SUPPLY CHAIN MANAGEMENT : DOES INFORMATION SHARING HELP MANAGERS WITH SERVICE CAPACITY DECISIONS ?*,” Prod. Oper. Manag., vol. 9, no. 1, pp. 40–55, 2000.

[10] M. Shamsuddoha, “‘Integrated Supply Chain Model for Sustainable Manufacturing: A System Dynamics ApSustaining Competitive Advantage Via Business Intelligence, Knowledge Management, and System Dynamicsproach,’” Sustain. Compet. Advant. Via Bus. Intell. Knowl. Manag. Syst. Dyn., pp. 155–399, 2015 .

[11] S. F. S. Brockhaus, “Using systems dynamics to achieve supply chain alignment,” Benchmarking An Int. J., vol. 23, no. 1, pp. 127–167, 2016.

[12] A. Sachan, B. S. S. Dinesh, A. Sachan, and B. S. S. Dinesh, “Developing Indian grain supply chain cost model: a system dynamics approach,” Int. J. Product. Perform. Manag., vol. 54, no. 3, pp. 187–205, 2006.

[13] A. Sidola, “System dynamics investigation of information technology in small and medium enterprise supply chain,” J. Adv. Manag. Res., vol. 9, no. 2, pp. 199–207, 2012.