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Determination of Scenarios for The Business Unit ofa Thermal Product Using System Dynamics: Case Study

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ABSTRACT : *The present case study consists of a study carried out in a commercialization company of special coatings with focus on the introduction of its new by-product in the market in Ciudad Obregon. The study had an objective. The information was made in the market. From the normal scenario, considering the demand for projects in the region under study, as well as the production capacity of the company. Similarly, a subproject where the product is the added value, a feasible sales model according to the company's turn and finally the establishment of sales policies for distributors and representatives. The results allow us to see that the application of system dynamics methodology, represents an advantage for making decisions based on data*.

KEYWORDS: *system dynamics, thermal product, scenarios, markets*

I. INTRODUCTION

Formerly the way to waterproof the roofs of the buildings did not include any type of industrialized material and had to use natural material taken from the place; the ceilings of the old haciendas, churches, convents, mansions, etc., used the system of terraces that consisted of a mezzanine consisting of wooden beams, handmade terracotta tiles and a layer of compacted clean earth that achieved an Approximately 40 to 80 cm depth depending on the area of each roof, finally applied a layer of red annealed brick handmade in the form of carpet and finally applied a solution of alum that allowed to achieve a waterproof surface [1].

The climate in Ciudad Obregón Sonora, Mexico is a desert climate. There is virtually no rain during the year in Ciudad Obregón, it is classified as BWh (Hot desert climates) according to the Köppen and Geiger climate classification. The average annual temperature in Ciudad Obregón is 25.9 ° C. Precipitation here averages 212 mm.Cimate-Data.org (2018). The construction companies in Mexico are beginning to use materials that mainly solve the internal temperature problems to be able to meet all the requirements of the authorities, hollow concrete walls, insulating foams, ultraviolet light reflective heatsink and even adobe. They are starting to use in all types of construction [2]However, the development of these is limited by the high cost and the lack of promotion of these materials. While the regulation of construction in Mexico is a new issue, based simply on the reduction of energy consumption, the future of the industry is simply based on creating sustainable and durable housing. (INEGI, Mexico - Annual Survey of Construction Companies 2013-2016, [3].The lowest average temperatures of the year occur in January, when it is around 17.8 ° C. Precipitation varies 58 mm between the driest month and the wettest month. The variation in temperatures throughout the year is 15.1 ° C.On the other hand, according to data collected from the INEGI, Ciudad Obregon has a total population of 433,050 people who reside in a total of 128, 490 homes (INEGI: Information by entity, 2015) which are divided into 230 colonies and subdivisions of the total 1, 879 totals in the entire municipality of Cajeme. [4]

A study [5] made to a small sample of the population of Ciudad Obregón in 2017 in order to estimate the acceptance of the market regarding a special coating to isolate the heat, in which one of the points highlight the perception that the population has of the high temperature in the water and its effect on health as well as what it invests for the solution of the aforementioned problem.A ninth of respondents say they are aware of having the problem of handling water with an increase in temperature that is easy to perceive. 8% point out that they are not sure of having perceived it, that is to say that the problem rarely appears.

Regarding the proportion of users who currently use some method to solve the problem; 80% said they do not buy any product that can solve the problem. 12% applies Polyurethane, one of the most used methods to combat the increase in temperature.The company Poliservicios y Comercialización del Noroeste, SA de CV is a leading company in the thermal sector of manufacturing that produces final consumer goods such as industrialized coatings with properties to isolate heat, waterproof, anti-corrosive and that do not spread the flame, the organization has four products in its catalog: G-Cover®Thermo Sköld, G-Cover®Primer Sköld, G-Cover®Epoxi Sköld and G-Cover®Flame KontröllFig.1 shows graphically the sales obtained from each G-Cover product in 2016, ordered from highest to lowest, being Thermo-Skold the product with the highest demand followed by First Skold; for the Thermo- Skold product with 58.92% of total demand, yields an annual weighted average capacity of 3, 535, 398 liters.

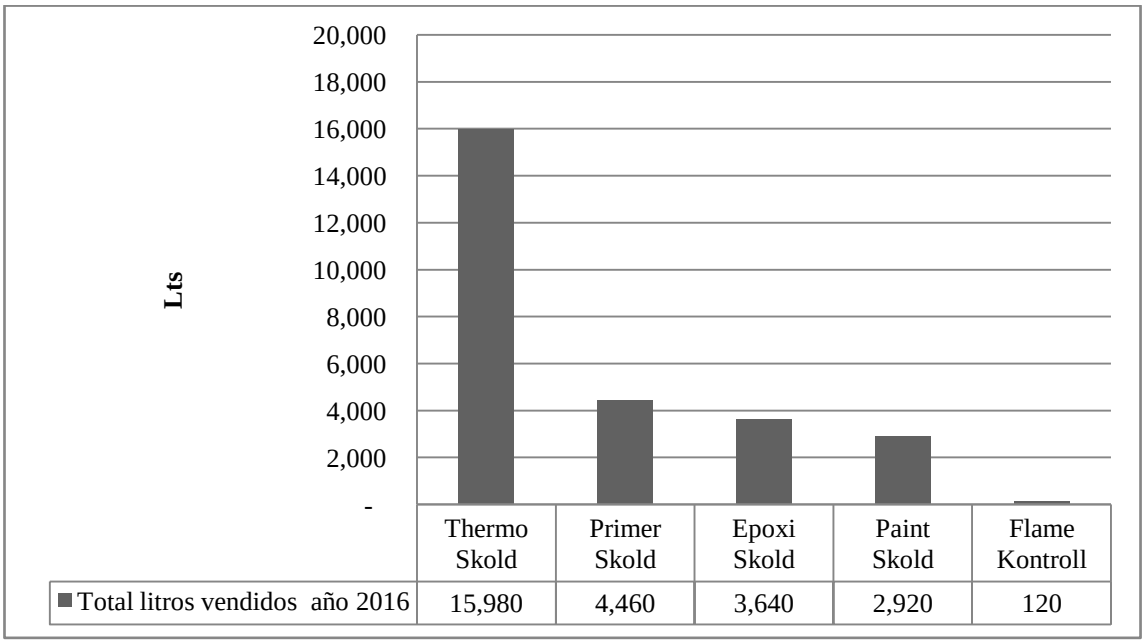

Figure 1. Annual demand graph vs Annual weighted average capacity, 2016
Source: Own elaboration with data obtained from Poliservicios y Comercialización del Noroeste, S. A. de C. V.

Fig. 1 shows the annual demand for G-Cover product, which shows that there are huge differences between the sales of 2016 and the capacity corresponding to each product such as Thermo-Skold with a fairly significant gap of 3, 519, 418 liters corresponding to the comparison between what can be produced (3, 535, 398 liters) and the annual demand (15,980 liters), having only a minimum percentage of 0.45 percent of sales.

Based on the aforementioned, it can be observed that the performance of the sales indicator referring to the Thermo-Skold product is mainly 0.45 percent, thus identifying an area of opportunity with respect to the goal established by the company under study for the compliance of your strategic objectives.The foregoing indicates that currently the company has a gap, between the current situation and the desired one, of 90%. It should be noted that this percentage in turn represents the level of impact of the company's profitability, which is why it is considered of great importance to studyGiven the above and considering each of the variables involved in the problem, the following research question was posed: What improvement actions should be implemented in the logistics of the distribution area, of a commercialization company of special coatings, that allow to increase the demand for a specific product in Ciudad Obregón?

The Objective is: To provide improvements through an analysis of contributing scenarios in the decision making regarding the distribution and commercialization of special coatings and, therefore, to reflect those improvements in the increase of the sales of a specific product.

II. LITERATURE REVIEW

Supply chain: According to the study carried out by [6]Define the Supply Chain as follows: Supply chain management for a broad approach is defined as coordination systematic and strategy of traditional business functions, and tactics through the functions of a particular company and companies involved in the supply chain, in order to improve the long-term performance of individual companies and the supply chain as a whole.

System thinking:[7]Defines systemic thinking as a conceptual framework, that is, a body of knowledge and tools, so that the total patterns become clearer, and to help modify them.In the same way, [8]refers to systemic thinking as the attitude of the human being, which is based on the perception of the real world in terms of totalities for its analysis, understanding and action. It is a philosophy based on modern systems seeking to reach tactical and not punctual objectives.Therefore, systemic thinking is the way to observe the context of various situations in their entirety in order to identify patterns with greater clarity for subsequent adjustment.

Systems dynamics: Discipline for the study of the relationships between the structure and behavior of a system with the help of computer simulation models [9].[10]defines the dynamics of systems as a method to improve learning in complex systems and develop computer simulation models, which help to learn about dynamic complexity, understand the sources of political resistance and design more effective policies

Simulation with system dynamics and scenarios : The systems can be analyzed using different mathematical tools, such as systems dynamics, which is defined as a methodology for the study and management of complex feedback systems. Additionally, it provides a single structure to integrate the functional areas of management. It is a quantitative approach that aims to link the organizational structure and the company policy with industrial growth and stabilitywith the purpose of presenting them, itemizing them, studying them, and analyzing them in diverse scenarios[11, 12, 13, 14,15,16, 17].

III. DESCRIPTION OF THE METHOD

The 6-phase methodology shown in Figure 1 was prepared according to a research into similar studies and traditional authors [9, 10, 11, and 12]. See Fig. 2

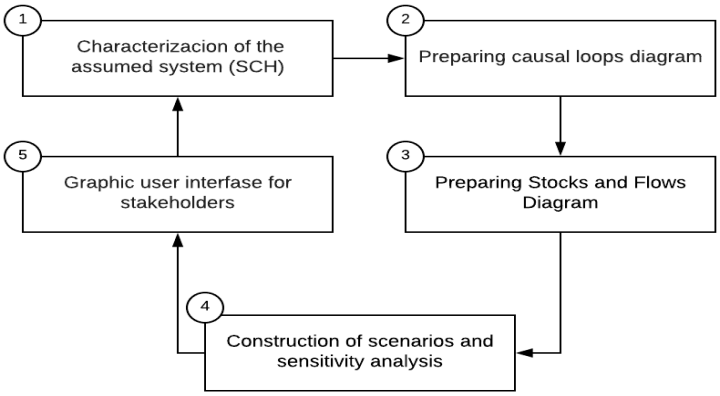

Figure 2. System dynamics method for the case study, personal elaboration, 2018

IV. RESULTS

Conceptualize the object under study: Using the Vensim PLE ® software, the Causal Diagram was elaborated, shown in Figure 3, in which each of the critical variables involved in the analysis of the environment of the central variable, Demand, is identified.

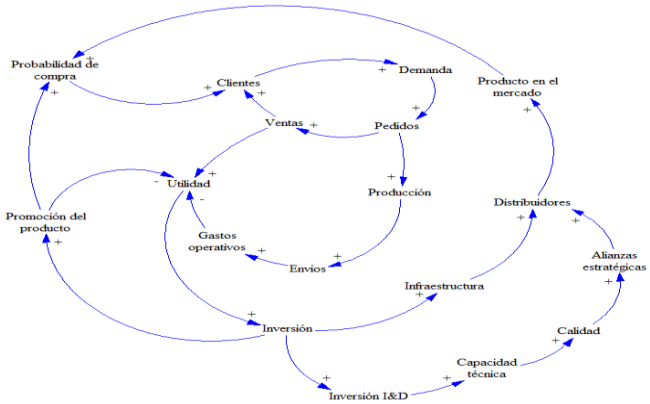

Figure 3. Causal Loops, personal elaboration, 2018

In Fig.3, different loops are shown, where four of them are the main causes of the company's situation. The smallest loop and where the aforementioned central variable is found is comprised of Demand, Orders, Sales and Clients, in addition to being directly related to the Probability of purchase variable. The interpretation of this loop is as follows: By increasing the probability of purchase, the demand for the product grows, which generates an increase in the number of orders and, at the same time, this requires an increase in the number of sales and, for Consequently, the client portfolio becomes larger.

According to the loop adjacent to the previous one, when increasing the Orders, it will require a higher Production of the sellers generating in this way more shipments, which would trigger an increase in the Operating Expenses and when this happens, the Utilities would be diminished. However, this same variable of Utility, is benefited by increasing Sales.The loop that surrounds the majority of the diagram shows that a greater Investment determines the growth of the company's Infrastructure and in the same way, the existence of new Distributors would grow in parallel. On the other hand, the increase in Distributors means a greater presence of the Product in the Market and, in turn, once again, the Probability of Purchase variable would increase.

Formulate the object under study: Once the object under study was conceptualized through the causal diagram and the definition of the variables, the development of the Forrester Diagram was continued, as shown in Fig. 4 through the use of the Stella ® software.

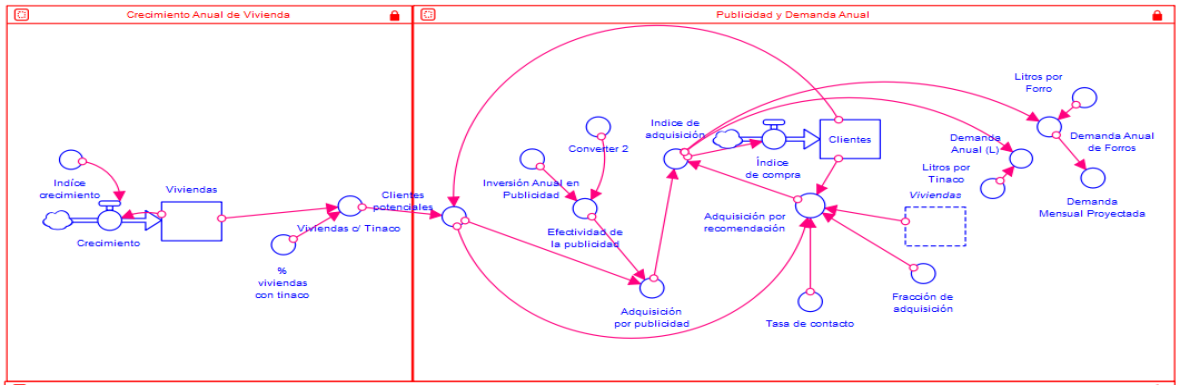

Figure 4. Forrester diagram, personal elaboration, 2018

The model is integrated by data that interrelate with demand, the central variable of the diagram. A stratification was carried out in four main elements whose behavior has direct or indirect repercussions with said variable: Population Growth, Advertising, Production and Net Profit. Also, data was integrated to calculate the investments made by the company. From the developed model it is possible to simulate the behavior of the Demand given different circumstances related to the increase or decrease of one of the 4 main elements mentioned above, that is, it is possible to know what would happen with the Demand of the product if there was no Word of mouth recommendation, for example. Within the model, there are 3 key indices that influence the acceptance of the product, whose value corresponds to previous studies carried out according to the Bass Diffusion Model (Sterman J., 2000) for the simulation of the process of how new products are adopted by a population.

Build and evaluate scenarios: This phase consists of carrying out a sensitivity analysis in order to know those parameters or situations before which the system model is sensitive or has a greater impact on the system. Consequently, the following parameters were determined: number of distributors of the product (Smart Cover) and investment in advertising thereof.Thus, the model has a wide range of modifiable parameters in addition to those mentioned, however, depending on the scope and purpose of the project, they were not carefully analyzed unlike the previous ones, such is the case of the production process in the factory From Queretaro, Mexico.Finally, to start the simulation of the model it is important to mention the consideration of the following dynamic hypotheses created from the information that gives rise to the model of the system:The supply capacity is modeled according to the production capacity of the company.The simulation was carried out for Ciudad Obregón and its determined capacity of potential customers who have a water tank in their homes.The simulation time of the model corresponds to a total of 10 years.It is considered a delivery time of 3 days from when an order is placed from Cd. Obregón until the product is sent from Querétaro.The data of the simulation are supported by the Bass Expansion Model on the adoption and diffusion of new products (Bass, 1969)The Production Costs were granted directly by the company under study.

This scenario refers to the normal situation of the system that represents the company under study, where there would be only three distributors and an investment of $ 5,000 MX monthly for advertising when launching the new product to the market.It should be noted that the data used for the projected demand were obtained by using different variables that directly affect it, such as the level of income of the population, population growth, effectiveness of advertising and the probability of consumption due to the effects of the temperature during the year, among others; same variables that were obtained from different sources such as economy magazines, articles, books, etc.Table 1 shows that the utility of the company, as regards the monthly units, is based on the investment in advertising and sale by distributors, that is, the utility increases when maintaining a presence in the advertising sector of the brand because this translates into sales and greater dissemination of the product. That is why the importance given to follow up the proposal regarding this issue, because it represents a fundamental role for the profitability of the company and consequently for its stability within the market.

Table 1.

Normal Situation - Demand - Sales - Monthly

Month	Demand	sales	Unsatisfied demand	Profit	Opportunity Cost
Enero	0	0	0	$ -	0
Febrero	85	11	75	$ 6,685	$ 11,353
Marzo	188	25	163	$ 10,456	$ 30,677
Abril	333	49	285	$ 15,616	$ 57,287
Mayo	431	69	362	$ 20,005	$ 74,208
Junio	557	99	457	$ 26,769	$ 95,043
Julio	558	107	450	$ 28,506	$ 93,517
Agosto	541	111	430	$ 29,395	$ 89,076
Septiembre	534	118	416	$ 30,736	$ 86,050
Octubre	430	98	333	$ 26,356	$ 67,779
Noviembre	238	53	185	$ 16,649	$ 35,408
Diciembre	57	12	45	$ 7,715	$ 4,774
Total Anual	3952	752	3200	$ 218,887.97	$645,171.57

Design of the interface with the user: As a final step, an interface with the user was developed in order to facilitate the management of the model to the sponsors of the project, it is divided into three parts which are shown below. In addition, for the optimal operation of the interface, a monthly update is necessary. It should be noted that an interface was made for both the annual and monthly demand.The first interface refers to a general situation of the company presented according to the value assigned to the modifiable parameters such as the cost or the sale price, to see the behavior of the model under those parameters. In the same way, buttons were placed that contribute to make the model friendlier, in such a way that the user identifies where to start it.

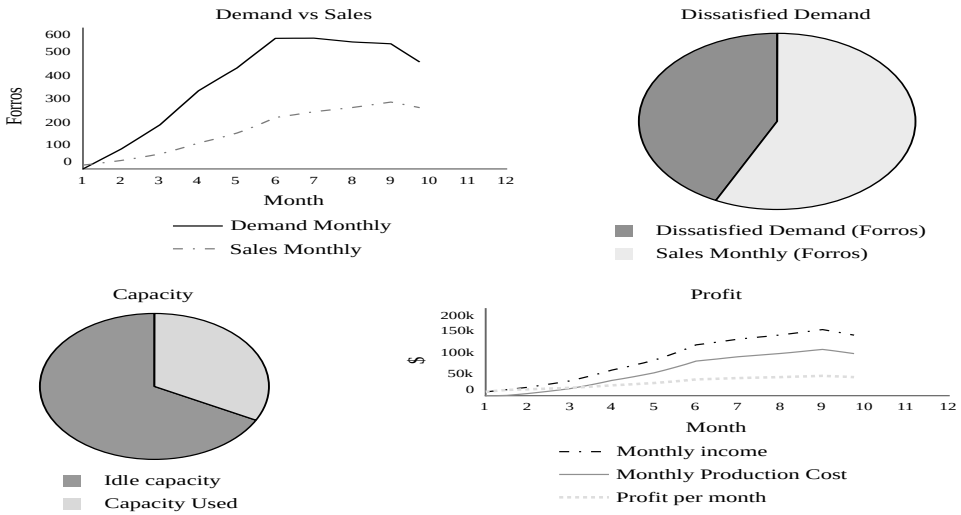

Figure 4. Demand behavior - Monthly sale - Normal scenario

After running the simulation of the model for the normal scenario, we obtained the results shown in Fig.4, where we observe data that includes the behavior of the central demand and monthly sales variables and the relationship, they have with the production capacity and obtained profits. As a result, a graph was obtained that shows the size of the Opportunity Costs that arises from a non-attended demand.

V. CONCLUSIONS

The objective of this project was to provide improvements to the decision makers, through an analysis of scenarios, regarding the marketing and induction of Thermo-Sköld products and its Smart Cover by-product. Therefore, once the project is concluded and each of the results obtained is based on, it is possible to mention the achievement of the same.For the fulfillment of the objective and the solution of the problem presented, it was necessary to adapt a methodology according to the phases of system dynamics, where it was defined defining the problem and observing the importance of knowing the situation surrounding the company from the international to the regional level and ending with the establishment of strategies to execute for the company's problems.

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REFERENCES

[1] Ayala, A. H. (2017). Lo que se debe saber acerca de impermeabilizantes. Obtenido de https://slidex.tips/download/desde-hace-aos-el-constructor-o-propietario-de-un-inmueble-se-enfrenta-con-un-pr

[2] Borbón, A. C., Cabanillas, R. E., & Pérez, J. B. (2010). Modelación y Simulación de la Transferencia de Calor en Muros de Bloque de Concreto Hueco. Scielo.

[3] INEGI. (2016). México - Encuesta Anual de Empresas Constructoras 2013-2016, Datos correspondientes a los años 2012-2015. Ciudad de México: INEGI. Obtenido de https://logismarketcl.cdnwm.com/ip/solinem-ltda-plataforma-solinem-para-constructoras-principales-problemas-de-empresas-constructoras-796179.pdf

[4] Heraldo. (2018). Disquis. Recuperado el 24 de Abril de 2018, de http://www.heraldo.com.mx/sonora/cajeme/

[5] Vidaurrazaga, F., & Rodriguez Villanueva, G. (2017). Encuesta Smart Cover. Plan de Negocios Smart Cover. Ciudad Obregón, Sonora, México: CERINNOVA.

[6] Sople, V. (2012). Supply chain management. Pearson.

[7] Senge, P. (1990). La Quinta Disciplina: El arte y la práctica de la organización abierta al aprendizaje. Granica.

[8] Ocaña, J. A. (2006). Pienso, luego mi empresa existe. España: Club Universitario.

[9] Aracil, J. (1995). Dinámica de Sistemas. Madrid: Edison.

[10] Sterman, J. (2000). Business Dynamics. Systems Thinking and Modeling for a Complex World. McGraw-Hill.

[11] Forrester, J. W. (1981). *Dinámica Industrial.*Buenos Aires: Ateneo.

[12] Richardson, G., & Pugh, A. (1999). *Introduction to system dinamics modeling.* USA: PEGASUS.

[13] Ogilvy, J. (2006). *Education in the information age:scenarios, equality and equaly.* Barkeley, CA, USA: GBN.

[14] Schwartz, P. (1991). *The art of the long view, planning for the future in an uncertain world.* New York, NY, USA: Currency Doubleday.

[15] Sterman, J. (2000). *Business dynamics: Systems thinking and modeling for a complex world*. Irwin McGraw-Hill.

[16] Ogilvy, J. (2006). *Education in the information age:scenarios, equality and equaly.*Barkeley, CA, USA: GBN.