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Business Games as a pedagogical tool for the development of skills in decision making

Business Games como herramienta pedagógica para el desarrollo de habilidades en la toma de decisiones

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Abstract

Before the Second World War, the Industrial Engineer's work focused on studies of plant distribution, quality control, production and inventories. Currently, these professionals are also required to carry out economic activities. The paper presents a business simulation game model that serves as a pedagogical tool for the teaching-learning process in the decision-making area, in the Marketing, Production and Finance disciplines. The research was carried out in four phases: data collection, reference frame construction, design construction, and testing. The theoretical and practical foundations were laid for future research, which improve the proposed model with the addition of Artificial Intelligence, Machine Learning and Deep Learning techniques, which optimize data processing and provide better support to the decision-making process.

Keywords: experience-based learning; finance; pedagogical tool; business games; marketing; prototype model; production; serious games; computational simulation; business simulation; educational software; decision support; decision making.

Resumen

Antes de la segunda guerra mundial, el trabajo del Ingeniero Industrial se centraba en estudios de distribución en planta, control de calidad, producción e inventarios. En la actualidad, se requiere que estos profesionales también ejecuten actividades económicas. El artículo presenta un modelo de juego de simulación empresarial que sirva como herramienta pedagógica en el proceso de enseñanza-aprendizaje para el área de toma de decisiones, en las disciplinas de *marketing*, producción y finanzas. La investigación se desarrolló en cuatro fases: recolección de datos, construcción del marco de referencia, construcción del diseño y pruebas. Se sentaron las bases teóricas y prácticas para futuras investigaciones que mejoren el modelo propuesto con la adición de técnicas de Inteligencia Artificial, *Machine Learning* y *Deep Learning*, que optimicen el procesamiento de datos y brinden un mejor apoyo al proceso de toma de decisiones.

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Palabras clave: aprendizaje basado en experiencias; finanzas; herramienta pedagógica; juegos de negocios; marketing; modelo prototipo; producción; serious games; simulación computacional; simulación empresarial; software educativo; soporte a la decisión; toma de decisiones.

1. Introduction

Before the Second World War, the Industrial Engineer's work focused on plant distribution studies, measurement, time and movement analysis, wage management, quality control, and production and inventory control. Nowadays, the business world requires that the professional in charge of the management and control of the processes, also carry out economic activities that take into account various market factors that affect the organization. In this scenario, the information generated from these relationships is stored and processed in information systems that help the decision-making process in activities such as resource optimization, production, market strategies and risk analysis, among others [1]. For this reason, it is essential that the training of the future Industrial Engineer is related to the use of technological tools and the changes that these entail, demanding great mastery of computer technology and simulation techniques.

This creates a great challenge for the teaching model, especially in higher education, which is seen in the need to design better strategies that use Information and Communication Technologies (ICT) to improve and update the generation and transmission process. of knowledge [2], and reform the teaching practice that requires innovation processes that are based on the use of new technologies, that allow the professionals who graduate to face the challenges that today's society demands, and offer a greater opportunity for success in the world of work [3].

In the 20th century, the teaching model was centered on the teacher, who transferred his knowledge and experience to the student, which restricted the space for the receiver to learn about other scenarios and points of view. These old models have been changed by learning methodologies based on student-centered learning (EBL), to which problems arise, and it is the student who asks their own questions and defines their teaching process, in such a way that they respond to their own knowledge objectives [4]. In this context, the boom in the use of computers started the concept of educational technology, which has brought new forms of learning, which is beneficial for the student who has available various ways of acquiring knowledge and skills, such as virtual laboratories and computer simulators, which allow working in environments that emulate conditions very similar to the real world, in which the student experiences, tests and appropriates the concepts of the

simulated scenario [5]. Likewise, the use of software applications in the educational field has led to the development of multiple computational tools at all pedagogical levels, ranging from applications to check mathematical concepts or formulas, to applications that track an entire course, including stages of knowledge assessment.

Instructional and audiovisual resources such as television, cinema, projectors, computers and other material and programming elements intervene decisively in contemporary educational technology, which together seek to offer new alternatives for training, making the process of flexibility more flexible. teaching and promoting the acquisition of new skills in the student [6].

One of the most common types of educational software is computer simulators, which are designed to represent various scenarios, and which have a series of characteristics that allow improving the teaching and training process, since they are built with a didactic purpose, they use the computer as a support and offer some interaction with the user that allows him to personalize his training process, adapting the contents and activities [7].

The paper presents a business simulation game design that serves as a pedagogical tool for the teaching-learning process in the decision-making area, in the Marketing, Production and Finance disciplines, in Industrial Engineering students at the Universidad del Valle-Buga.

1.1. Simulation as a teaching and learning method

Throughout history, humanity has had to appeal to the technique of simulation in different contexts that allow it to understand the behavior of environments that are difficult to study. Depending on the environment where the simulation is used, there are several definitions of the concept. At a general level, the term can be defined as the generation of real-life models in controlled scenarios, and applicable to any area of knowledge. Such simulation models are nothing more than an approximation designed in a prototype and which tries to capture in the best way the reality that is being represented. These models are classified as: discrete or continuous, deterministic, or stochastic and static or dynamic [8].

The simulation uses a set of logical, mathematical, and probabilistic relationships that describe the behavior of a system in a given event. Furthermore, simulation is not

an optimization technique. This allows to predict the behavior of a system given some inputs, or randomly generated values, with the hope of finding parameters that configure an optimal and desirable system [9].

Even before computers became available, management experts used Operations Research and financial data concepts to build models of business enterprises, services, and their components. These models were used in simulations to explore the impact of system design features, such as possible numbers and locations of highway toll booths, fire stations in an area, or resource changes in an investigation, finance, operations, marketing and distribution. The simulation then improves learning, which occurs in two dimensions, from the point of view of the impact of new knowledge in the workplace, since it can immediately begin to apply what has been learned, and from the point of view of the increase in the learning transfer rate.

Simulation games as a learning technique allow the student to play in virtual worlds that reflect reality, making the player connect through a concrete experience and contextualize what he is living with what has been learned, increasing motivation and encouraging his curiosity. Similarly, simulators are an effective tool in developing economic and managerial skills, which eliminate the risk and associated costs of making decisions in the real world [10].

In the academic sector, many studies verify the effectiveness of simulators, showing that there are significant differences in the learning of the student who uses an educational simulator and the student who follows the traditional method of teaching. In this case, the student who uses the simulator shows a greater understanding of the study problem, improving the learning dynamics, which translated into more complete and precise answers [11]. Some examples of the use of educational simulators in various areas are: a) in medical education, it has proven to be an effective means of transferring knowledge and skills that health professionals must acquire, oriented to patient safety [12], b) in mathematics, improving the learning of equivalent fractions [13], c) as a didactic resource in the teaching of statistics [14], d) in decision-making, improving the learning of related concepts [15], e) in financial management, production and marketing as an adaptive learning strategy [16], f) as a tool for learning mechanical physics [17], g) as a tool for inclusion in students with Imperfect Osteogenesis in physical activities [18], h) in improving the quality of service in an emergency system [19], i) as a tool for architectural design and evaluation, and sustainable design [20], j) in the planning of tasks in the agricultural sector [21], and

k) in manufacturing processes in terms of quality improvement, reduction in costs and inventory, and better product management [22] [23].

1.2. Simulation as a teaching and learning method

The decision-making process within an organization is executed at various levels of command related to the hierarchical structure, and which can be strategic, tactical and operational. In any case, these elections involve the use of institutional resources, such as the information and computer technologies that support the process [24].

Taking into account that generally, decision-making takes place in an environment of uncertainty that must include values from the environment, it is essential that the personnel in charge of the process have a deep knowledge and experience of the subject, which is related to the management of the information [25]. To achieve this, different technological tools, such as applications for Decision Support Systems (DSS), Management Information Systems (MIS) and Expert Systems (ES), among others, have been used as a management, control and support tool. to decision making [26]. Similarly, there are often two ways to perform analysis of a business scenario using experimental techniques. The first is to experiment directly with the problem itself, which represents unnecessary risks for the organization. And the second is to design a prototype model of the problem scenario, which reliably represents the required conditions of the problem. In this second technique, the created model can be of three types: 1) mental models, 2) physical models through an analogical or iconic representation, and 3) mathematical, symbolic or logical models [27], among which are the models of computer simulation that are based on statistical methods for the description of the nature of the variables and factors that are part of the system [28].

Decision-making simulators, called “Business Games” in English, are computerized scenarios that adequately represent realistic conditions, in which the player develops decision-making skills by observing the results of his decisions.

The “Business Games” belong to the category of “Serious Games”, in which software programs are built in order to be a formal teaching or learning tool, which is gaining acceptance in the educational world, when used as training strategy, not only in educational institutions, but also in the business sector, due to its ease of use and the possibility of learning by playing [29]. One of the types of “Business Games” is total business games, which include the main functional areas of the organization: marketing, production, and finance. This

type of business game involves some complexity, since in addition to integrating the main functional areas, they also incorporate external factors, such as general economic conditions, fluctuations in demand, productivity levels, interest rates, etc., and in which the game calculates what would have actually happened with those decisions and produces printed results for a quarter, a month or a year, in a few seconds [30].

2. Methodology

The investigation was developed under a qualitative comparative approach, with the aim of establishing the bases of a reflective process against the results obtained from the proposed model. Likewise, the research was carried out basically in four phases: a) Data collection: with the terms “computer simulation”, “simulation in education”, “simulation in industry” and “business simulators”, among others. A search for information was carried out in primary sources, such as bibliographic databases and articles from scientific journals in order to understand the study topic. b) Construction of the frame of reference: based on information from the previous phase, it was contextualized and delimited. the research topic. Marketing, Production and Finance areas were identified as the most related according to the purpose of the study; c) Design and construction: An application was implemented that used computational simulation and a total company game approach, which included the areas identified in the previous phase, to recreate a business scenario which can emulate an organization with six production plants. located in different countries; and d) Tests: the scenario simulation was performed, where the data for the Marketing, Production and Financial modules were entered.

2.1. Proposed model

In Latin America, since the beginning of the 1990s, an increasing interest has been observed regarding assessment and accreditation of the quality of public service in higher education. Compared with the USA's and Europe's structures, there is a similarity in the stages of the models: self-assessment, peer evaluation, and final evaluation by the corresponding body. However, there are differences between the scope of assessment and accreditation. In some cases, there has been more self-assessment than accreditation under the regulatory idea of encouraging self-regulation by institutions; in others, more accreditation than self-assessment to increase government control and oversight [5].

The proposed simulation model allows us to recreate a business scenario in the Marketing, Production and Financial areas that an organization emulates with six

production plants located in different countries. The model has the characteristic that each simulation is executed quarterly using the variables that can be defined in the game. In addition, all the values and quantities referenced below, can be modified or assigned by the user who runs the model.

The game has the following characteristics:

- Teams: Made up of four students. One of the members served as president of the company; He will have the last word in the decisions that will be made within the company, in addition to being the only person who can enter the data or “inputs”, and the others will have a specific position within it.
- The Company: Virtual organization dedicated to selling two types of products worldwide. The participants will be in charge of setting the name, mission, vision, values and objectives for the company they would manage, as well as looking for the best strategies to win the market and therefore profits. They also had to decide the name of their products and the markets they would enter or withdraw from, for this they would have an “advisory team” or “administrative council” which will be discussed below.
- Plants: The company will have two plants, each manufacturing a single product, product 1 or product 2. These may be located in different countries. The initial location of the plants will be assigned by the simulator. After running the simulation, the plants can be moved between the countries where the company will have a market. Initially both plants will be the same size, being able to make them larger or smaller depending on what the company needs to cover its production needs. The quality of each product will be determined by the country in which the plant is located, that is, there will be countries in which the production costs will be lower and the technology better.
- The Product: Each company will manufacture and sell two products that will be wrist watches. Product 1 (P1) is of low quality, focused on middle or low class markets; Competition in this market is very close and is mainly defined by low prices. Product 2 (P2) will be of better quality, aimed at a medium-high and high sector. It can be said that its distinctive characteristics will be quality and design. Both products will compete in totally independent markets, the improvement or deterioration of one, will not affect the market of the other at all.
- The Market: At the start of the game, each company will have a market for its products in the countries of Japan, China, Colombia, England (UK), Germany and the

United States (EEUU). The markets will be as large as the real size of each country and the behavior of these markets will be the same as that experienced in real life, especially in terms of demand, structural cost, growth rate and other macroeconomic parameters. Consumers in each market will have different purchasing preferences; for example, consumers in more affluent countries will be less price sensitive and more quality sensitive. It will be essential that each team identify these preferences.

- **Administrative Council:** The Administrative Council will be integrated by two professors of Industrial Engineering. They were presented with the results obtained each term to evaluate the actions taken by the administration (the team). It is this assembly that makes the capital investment decisions, plant changes, for this a monthly meeting was held.

- **Meetings:** Every term period, the team will make presentations at a professional level to report to its partners the situation the company is in; These were carried out every one year term, that is, every four simulated quarters, for this the time will be taken in terms of the simulation. This is where the student will gain more experience as he will share real-life information and feedback will be given so that failures are improved for the next meeting.

2.2. Inputs

The teams will run their companies through the control they exercise on certain variables, called inputs. The inputs are actually inputs made and that represent the decisions made by the management team of each company, each period represents 3 months of simulated time.

2.2.1. Marketing decisions

Prices for both products in different countries: The team will be able to choose the prices of both products in all markets.

Tenders: In addition to the six markets available for the sale of products, there will also be an institutional market: The United States Government. This market is divided into two types of opportunities to sell P1:

- One of them is carried out each period, it is played for a quantity of units announced with a period of anticipation, it wins the lowest price (equal to or above the cost), regardless of quality levels.
- The second. All existing companies participate in this auction, the winner will be the one with a low price, but with an acceptable level of quality.

Container purchase or rental budget: The company will need containers to deliver its products to different countries. This variable indicates how many containers you want to buy or rent to deliver the products in each period, the cost to buy each container will be 3,000 USD and it has the capacity to transport 1,000 units per period. The cost to rent a container is 2,000 USD per period. Every period, 5% of the containers must be replaced. In the event that the demand exceeds the shipping capacity, additional containers will automatically be rented for emergency shipments and these will cost 3,000 USD each and will only serve one period.

Budget for marketing expenditure by country: Each period, the budget allocated for marketing each product in each country will be indicated. The effects of marketing strategies change over time in response to the actions of competitors.

Marketing Consulting: It is possible to hire consultants in each period, with the aim of improving the effectiveness of marketing programs. The consultancy is per product unit and can be directed directly to one of the six countries or it can be distributed among the available markets.

2.2.2. Production decisions

Expenditure on research and development for both products: It is possible to select the budget for each period. Budgets for each product must be entered separately. The influence of this factor will translate into the attractiveness of the product in the eyes of customers.

Production consulting fees: The company has the possibility of hiring consultants in order to improve the efficiency of manufacturing operations. Consulting is direct and can be used in both products. The biggest impact of production consulting is on variable manufacturing costs.

Production quantity for each product: This variable refers to the number of units to be produced in the two factories where the products are manufactured in each period.

Budget for expansion of the plant (s): The company may expand the capacity of its factories at any time, as long as a maximum of 15% of capacity is expanded in each period. Expansion costs per unit are 16 and 25 USD respectively, depending on the product. Factories depreciate to 1.25% per quarter. Expansion takes time to complete, extra capacity will be available a period after it was purchased.

Decrease in capacity: The company can partially sell the capacity of your company for 75% of the cost per unit. The capacity reduction will be available next quarter.

Factory relocation: The teams have the ability to move their factories from one place to another, entering the number of the country to which they want to move and the number of units that make up the maximum capacity of that factory. Due to the simulation, this change will be reflected in the next simulated quarter.

2.2.3. Financial decisions

Debt Management: Each company has a limited line of credit, this allows it to obtain resources to finance its operating costs. Companies will be able to make payments or increase their debt, as they wish. The simulation does not make automatic debt payments; the team must designate the amount for this purpose, failure to do so will increase the amount of the debt each period. In this variable, the user must place the amount to be paid to amortize the loan that the company has, for practical purposes, an initial loan amount of 9,357,642 USD will be assumed with a nominal interest rate of 24.01%.

Payment of dividends: The simulation distributes the dividends in the period in which the managers decide to pay them.

Insurance: The team will control two variables related to insurance: Property Casualty Insurance, which protects the company from damage or physical loss of property caused by fires, natural disasters, theft, etc., and Product Liability Insurance, which protects the company. of demands from customers.

2.3. Outputs

The teams have at their disposal three formats in which the results of each movement or period are available. The formats of results include: Market report, Production report and Financial report for each period, and that result from running a simulation cycle.

2.3.1. Market report

This report provides information about the positioning of the company and its performance in the world market with respect to competitors. The first part of this report contains information about the total demand for each product, total sales, and the total marketing spending made by the company in each country. This report also includes a brief profit / loss analysis in each country, it is useful to identify costs in each market, it helps to have a perspective of profit margins separated by country and by

product. This information allows knowing the profitability of each market and the costs associated with it. It is important to take into account contribution margins, this includes all costs related to doing business in each country.

In addition, each market report contains data on the prices at which the company's products were sold (P1 and P2), this section summarizes all the prices of both products, offered by the five companies in the world market.

2.3.2. Production report

This report describes the activity that takes place in the two factories where the products are manufactured. Includes transportation costs and factory relocation activities. This report is divided into:

Product information: The design of this report simplifies production planning and cost accounting, so production costs can be easily identified. This part is divided into three columns:

1. Current Period: This column indicates what happened in the period that ended.
2. The second column shows the costs that apply if the factory is working at its maximum capacity. This may differ from current costs if you are operating below full capacity.
3. Maximum Capacity in the Next Period: Predicts the expected manufacturing costs in the next period.

Inventory Information: The report provides important information about inventory levels at both factories. That is, the amount of product that was stored at the end of each period. According to the simulation, the optimal level of inventory stored is 10% of the production capacity. If this percentage is exceeded, it means that our company has excess inventory, which affects our costs; on the contrary, in case of having less than 10% stored at the end of each period, an automatic product purchase is made in order to satisfy this requirement.

In addition, the simulation informs managers if they have required "emergency sales", this type of sales is carried out when one of the competitors falls into stock out, in case of falling in this situation, the simulation will automatically buy from competition the number of units necessary to cover the demand for each product.

Additional information: Refers to transportation costs and shipping capacity that the factory has. Here they tell us about: the number of containers available, their depreciation in that period (5%), the expenses for handling the containers, the cost for renting containers,

the emergency rent and the costs for moving the product to each country. Information about factory relocation, % Quality Level and Efficiency indicators is also available.

2.3.3. Financial report

The financial report contains financial data about the company and the competition, and is divided into seven areas:

1. Balance Sheet: This report contains information on all the companies that are in a world. You have access to inventory costs, pricing system, who has obtained more loan resources, ROE and dividend payment.
2. Income Statement: It is quite brief, however, it gives useful information about the competitors, for example: Total sales, net profit and ROE for the period.
3. Transport Rates: It expresses the cost of shipping the products from one country to another. The transportation fee represents the marginal cost of transportation.
4. Export Rates: Similar to the transport rate, however, they are applied to the profits of the company in each country, not to manufacturing costs.
5. Detailed Income Statement: Here is the company's income statement, most of the concepts that are used are used in the same way in reality as in the simulation, however, there are some about which clarifications should be made :
 - Plant Sale Loss: Indicates the 25% loss that results from the sale or reduction of a factory's capacity.
 - The Depreciation rate: In the case of factories, depreciation will be 1.25% per period and containers will depreciate 5% per period.
 - Taxes: To facilitate the handling of taxes, these are calculated with a rate of 21%, applied to all taxable items.
6. Insurance Information: The amount invested in the two types of insurance available, used in the period ended, is explained.
7. Extra useful information for the following period: Contains additional information regarding the current debt levels and the maximums allowed based on the company's profits. Information about interest rates also appears.

3. Result

The proposed simulator model basically contains three modules: Marketing Module, Production Module and Financial Module. Each of these modules is made up of two elements: a form and a report. In the forms, the necessary information is requested from the users to be able to run the simulation and generate the reports for each module.

3.1. Marketing module

Marketing Form: In this form, the data corresponding to Marketing Decisions defined in the proposed model is requested.

This form was divided into five areas, where users are asked for the price of P1 and P2, the marketing spending values in the quarter and the values per product unit, and from the marketing consultancy in the six countries, the number of containers to buy and rent in that period and the sale price of P1 to compete for the acquisition of Forward contracts (Fig. 1).

Marketing Report: The marketing report is made up of two tabs. The first shows product statistics (Fig. 2), and the second shows the prices of the products of the other 5 companies (Fig. 3).

The following information will appear in the product statistics section:

- Total demand: Total quantity of units that buyers or consumers are willing to acquire to satisfy their needs.
- Total Sales: Number of units sold by all companies.
- Total market: Amount of potential consumers that the product has in each of the countries.
- Company demand: Number of units that consumers are willing to buy from the company.
- Company sales: Number of units sold by the company, this value will be generated randomly by the simulator.
- Forward Contracts: Number of units sold to the EEUU institutional market. This field only appears in P1 statistics, since the option to participate in those tenders is only presented for this one. The program will internally compare the company's prices with other organizations in the world. If the company's price is the lowest of all, the simulator randomly generates the quantity of the product to be sold in this market.
- Marketing Expenses: Value corresponds to the sum of the marketing expense values for the quarter and the marketing consulting expense for the units sold.
- Sales revenue: Revenue in dollars (USD) from the sale of products (country sales price * company sales)
- Production cost: Corresponds to the variable expenses of producing the product (variable cost of production * company sales)
- Gross profit: Represents the profits resulting from subtracting from sales revenue, production costs.
- Import tariff: Sales tax charged by each country to sell the products.
- Contribution margin: Value obtained from subtracting from gross profit marketing expenses and import tariffs.

Business Simulator - Marketing report

DATA TO GENERATE MARKETING REPORT

Period 1

Product price		Marketing expenses	
Product 1	Product 2	Product 1	Product 2
Japan: 36.42	Japan: 60.07	Japan: 83739	Japan: 123035
Colombia: 40.63	Colombia: 51.82	Colombia: 43289	Colombia: 415564
China: 41.63	China: 56.49	China: 29631	China: 320758
UK: 47.11	UK: 67.18	UK: 163485	UK: 323226
Germany: 38.28	Germany: 57.42	Germany: 124927	Germany: 304327
EEUU: 38.28	EEUU: 57.42	EEUU: 309500	EEUU: 458250

Marketing consulting expenses	
Product 1	Product 2
Japan: 0.32	Japan: 0.32
Colombia: 0.66	Colombia: 0.66
China: 0.77	China: 0.77
UK: 0.86	UK: 0.86
Germany: 0.41	Germany: 0.41
EEUU: 0.55	EEUU: 0.55

Containers for the period

Number of containers to buy:

Number of containers to rent:

Forward contract

Contract value:

Next > Cancel

Figure 1. Marketing Form

Business Simulator - Marketing report

Product statistics Price products

Product statistics 1

	Japan	Colombia	China	UK	Germany	EEUU	Total
Total demand	210.049	151.920	175.408	161.031	225.825	336.439	
Total sales	210.049	151.920	175.408	161.031	225.825	336.439	
Total market	42.019.985	3.955.000	1.364.002	659.999	1.054.999	20.024.001	
Demand company	55.873	20.761	52.022	36.853	58.081	17.663	241.253
Company sales	55.873	20.761	52.022	36.853	58.081	17.663	241.253
Forward contracts	0	0	0	0	0	0	0
Marketing expenses	101.618.36	56.991.26	69.687.94	195.178.58	148.740.21	319.214.65	891.431
Sales revenue	2.034.894.66	843.519.43	2.165.675.86	1.736.144.83	2.223.340.68	676.139.64	9.679.715.1
Production costs	817.421.99	303.733.43	761.081.86	539.159.39	849.725.03	258.408.69	3.529.531.39
Gross profit	1.217.472.67	539.786	1.404.594	1.196.985.44	1.373.615.65	417.729.95	
Marketing expenses	101.618.36	56.991.26	69.687.94	195.178.58	148.740.21	319.214.65	891.431
Import fees	244.187.36	0	173.254.07	173.614.48	222.334.07	0	0
Contribution margin	889.546.31	496.497	1.201.708.93	859.885.96	1.026.354.58	108.229.95	

Product statistics 2

	Japan	Colombia	China	UK	Germany	EEUU	Total
Total demand	168.812	30.024	119.759	217.749	298.598	337.508	
Total sales	168.812	30.024	119.759	217.749	298.598	337.508	
Total market	38.560.789	2.900.001	9.119.998	2.048.000	2.346.999	11.167.998	
Demand company	28.061	43.225	25.327	54.468	16.279	30.741	198.101
Company sales	28.061	43.225	25.327	54.468	16.279	30.741	198.101
Marketing expenses	132.014.52	444.092.5	340.259.79	370.068.48	311.001.39	457.157.55	2.072.594.23
Sales revenue	1.685.624.27	2.239.919.5	1.430.722.23	3.659.160.24	934.740.18	1.765.148.22	11.715.314.64
Production costs	560.658.78	863.635.5	506.635.46	1.088.270.64	325.254.42	614.205.18	3.958.057.98
Gross profit	1.124.965.49	1.376.284	924.688.77	2.570.889.6	609.485.76	1.150.943.04	
Marketing expenses	132.014.52	444.092.5	340.259.79	370.068.48	311.001.39	457.157.55	2.072.594.23
Import fees	202.274.91	0	114.457.78	365.916.02	93.474.02	0	0
Contribution margin	799.655.58	960.720	489.472.99	1.881.747.58	211.684.74	692.693.04	

Figure 2. Marketing Report - Product Statistics

Business Simulator - Marketing report

Product statistics Price products

Product price 1

	Japan	Colombia	China	UK	Germany	EEUU
Product price 1 (U...)						
Company 1	82	92	46	89	22	48
Company 2	23	95	99	100	56	82
Company 3	56	80	43	37	63	66
Company 4	91	86	85	39	86	44
Company 5	30	30	36	66	42	76
Average	56.4	92	46	89	22	48

Product price 2

	Japan	Colombia	China	UK	Germany	EEUU
Product price 2 (U...)						
Company 1	82	92	46	89	22	48
Company 2	23	95	99	100	56	82
Company 3	56	80	43	37	63	66
Company 4	91	86	85	39	86	44
Company 5	30	30	36	66	42	76
Average	56.4	92	46	89	22	48

Figure 3. Marketing Report - Product prices

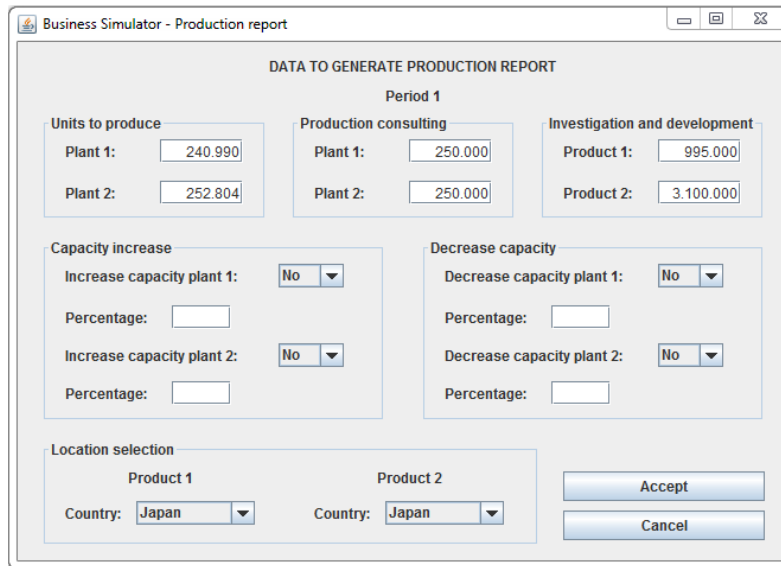


Figure 4. Production Form

It is important to note that each of these items is calculated for each country where the company markets its products.

It is important to note that each of these items is calculated for each country where the company markets its products.

3.2. Production module

Production Form: In this form, the data corresponding to Production Decisions defined in the proposed model is requested (Fig. 4). This form was divided into six areas where users are asked for the following information:

- **Production units:** Number of units that you want to produce in each of the plants.
- **Production consultancy:** Amount of money to be invested in the consultancy in the quarter, in order to improve the efficiency of the plants.
- **Research and development:** Amount of money to be invested in research and development for each product.
- **Capacity increase:** Percentage of the plant's production capacity that will be increased for the next period, that is, the number of other units that the plant will be able to produce the following period.
- **Decrease in capacity:** Percentage of the plant's production capacity that will decrease for the next period, that is, the number of units that the plant will not be able to produce the following period.
- **Location selection:** Selection of the country where you want to locate the plant in the next period.

Production Report: The production report (Fig. 5) is made up of the following information:

- **Plant location:** Shows the country where the plant produced that period.
- **Production quantity:** Quantity of units produced by the plant.
- **Fixed costs:** whose value remains constant, regardless of the level of activity of the company. They can be identified and called as costs of "keeping the company open", in such a way that production is carried out or not, whether the product is sold or not.
- **Variable Cost:** They vary proportionally, according to the level of production or activity of the company. They are the costs for "producing" or "selling". (variable cost for the number of units + expenses for production consulting)
- **Total cost:** Value obtained from adding fixed costs and variable costs.
- **Variable cost per unit:** Value obtained from dividing variable costs by the quantity of production.
- **Total cost per unit:** Value obtained from dividing total costs by the quantity of production.

It should be taken into account that of the data shown in the first tab of the production report, the production quantity, fixed costs, variable cost, total cost, variable cost per unit and total cost per unit are shown for three different columns. which have the name of:

- **This period:** Shows the values for the quantity to be produced in the two plants, the decision of how much to produce will be made by the user.
- **Full Capacity:** Shows the costs that apply in case the factory is working at its maximum capacity.

Business Simulator - Production report					
Plant information					
Plant 1					
LOCATION	Colombia		Total capacity	300.000	
Item	This period	Full capacity	Next period		
Production quantity	240.990	300.000	300.000		
Fixed cost	1.667.505	1.667.505	1.667.505		
Variable cost	3.960.030	4.744.000	4.744.000		
Total cost	5.527.535	6.411.505	6.411.505		
Variable cost per unit	16,02	15,81	15,81		
Total cost per unit	22,94	21,37	21,37		
INVENTORIES					
Initial inventory	0	Missing units			LOWER SALE PRICE
Quantity sold	226.026			Japan	
Quantity produced	240.990			Colombia	
Final inventory	14.964	Purchase cost inv.		China	
Value	343.226,01	Emergency units		UK	
DESIRED INVENTORY	30.000			Germany	
				EEUU	
Plant 2					
LOCATION	EEUU		Total capacity	300.000	
Item	This period	Full capacity	Next period		
Production quantity	252.804	300.000	300.000		
Fixed cost	1.509.970	1.509.970	1.509.970		
Variable cost	5.222.655	6.151.000	6.151.000		
Total cost	6.732.625	7.660.970	7.660.970		
Variable cost per unit	20,66	20,5	20,5		
Total cost per unit	26,63	25,54	25,54		
INVENTORIES					
Initial inventory	0	Missing units			LOWER SALE PRICE
Quantity sold	205.154			Japan	
Quantity produced	252.804			Colombia	
Final inventory	47.650	Purchase cost inv.		China	
Value	1.269.005,1	Emergency units		UK	
DESIRED INVENTORY	30.000			Germany	
				EEUU	

Figure 5. Production report

• **Next period:** Shows the values for the production of all the installed capacity for the next period. This column differs from the previous one if the user made the decision to increase or decrease the capacity of the plant, otherwise it will be equal to the full capacity column.

The report also shows:

- **Initial inventory:** Goods in stock and available for sale at the beginning of the period.
- **Quantity Sold:** Total quantity of units sold of the product in the six countries.
- **Quantity Produced:** Quantity of units that the user determined that the plant should produce.
- **Final inventory:** Goods in stock, available for sale at the end of the period (Initial inventory plus quantity produced minus quantity sold)
- **Value:** ending inventory value (ending inventory for total cost per unit)
- **Desired inventory:** Quantity of units considered to be left as inventory at the end of the period. For the simulator the ideal amount of inventory is 10% of the installed capacity in the plant.
- **Missing units to cover minimum inventory:** if the quantity of the ending inventory is less than the quantity of the desired inventory, the simulator will automatically buy the missing quantity to fulfill this requirement.
- **Inv. Purchase Cost:** Cost of purchasing the quantity of missing units to fulfill the inventory condition. The simulator will automatically choose the company to buy

the missing units from, the selection criteria is the lowest price.

- **Emergency Units:** Quantity of units that the company must buy because the quantity sold is greater than the quantity produced plus the final inventory.
- **Unit Cost. Emergency:** Cost of purchasing the number of emergency units to meet the quantities sold. The simulator will automatically choose the company to buy the missing units from, the selection criteria is the lowest price.
- **Lower sale price of the competition:** in this part the simulator will show the lowest price at which the competition sells its products in the six countries.

3.3. Financial module

Financial Form: In this form, the data corresponding to financial decisions defined in the proposed model is requested (Fig. 6). This form was divided into five areas where users are asked for the following information:

- **Loan amortization:** Amount of money budgeted to pay the installment of the loan or loans that the company has.
- **Insurance:** Amount of money to invest in the purchase of accident and / or liability insurance.
- **Compensation:** Amount of money that will be used to give bonuses to employees, for their good performance in the period.
- **Loans:** Amount of money requested from the bank. The user must take into account the levels of indebtedness

since if this is greater than 50% the simulator will automatically deny it.

- Payment of dividends: Users decide if they wish to pay dividends to shareholders at the end of the period and what percentage of profits to distribute among them.

Financial report: The financial report is made up of three tabs. The first shows the balance sheet and income

statement of the five competing companies (Fig. 7). The second shows the values corresponding to the export rates and product transport rates (Fig. 8), and the third shows the user the detailed income statement of the company, the information on the amount invested in the purchase of insurance, in addition of the debt level indicator (Fig. 9).

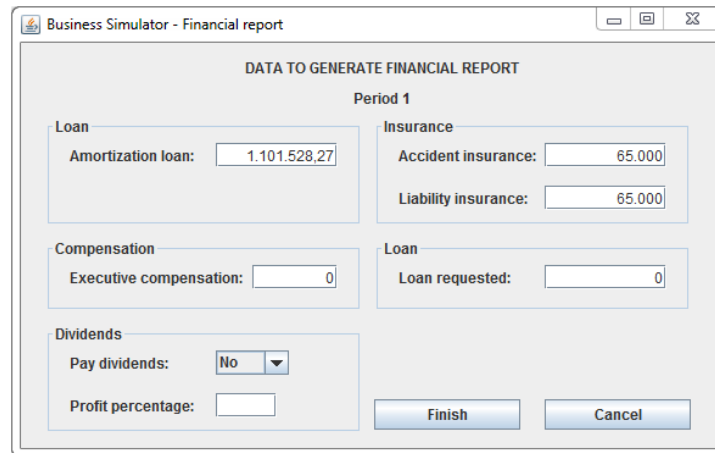
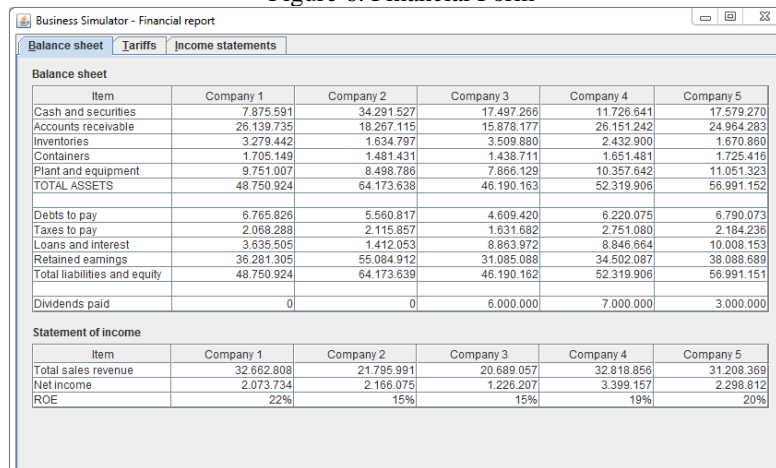


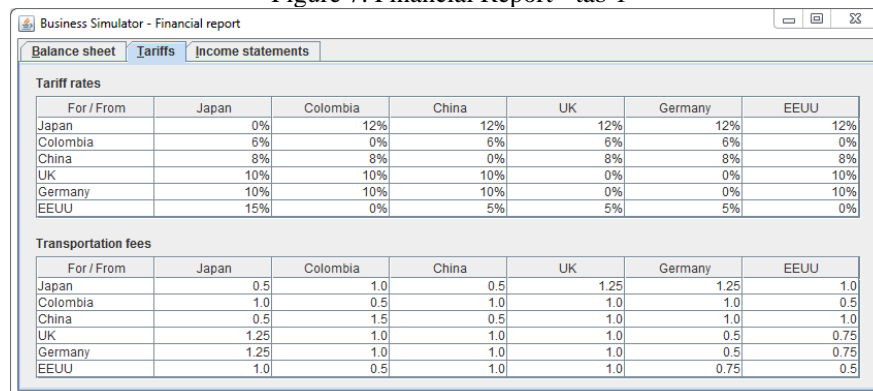
Figure 6. Financial Form



Item	Company 1	Company 2	Company 3	Company 4	Company 5
Cash and securities	7.875.591	34.291.527	17.497.266	11.726.641	17.579.270
Accounts receivable	26.139.735	18.267.115	15.878.177	26.151.242	24.964.283
Inventories	3.279.442	1.634.797	3.509.880	2.432.900	1.670.860
Containers	1.705.149	1.481.431	1.438.711	1.651.481	1.725.416
Plant and equipment	9.751.007	8.498.786	7.866.129	10.357.642	11.051.323
TOTAL ASSETS	48.750.924	64.173.638	46.190.163	52.319.906	56.991.152
Debts to pay	6.765.826	5.560.817	4.609.420	6.220.075	6.790.073
Taxes to pay	2.069.288	2.115.857	1.831.662	2.751.080	2.184.236
Loans and interest	3.635.505	1.412.053	8.863.972	8.846.664	10.008.153
Retained earnings	36.281.305	55.084.912	31.085.088	34.502.087	38.088.689
Total liabilities and equity	48.750.924	64.173.638	46.190.162	52.319.906	56.991.151
Dividends paid	0	0	6.000.000	7.000.000	3.000.000

Item	Company 1	Company 2	Company 3	Company 4	Company 5
Total sales revenue	32.662.808	21.795.991	20.689.057	32.818.856	31.208.369
Net income	2.073.734	2.166.075	1.226.207	3.399.157	2.298.812
ROE	22%	15%	15%	19%	20%

Figure 7. Financial Report - tab 1



For / From	Japan	Colombia	China	UK	Germany	EEUU
Japan	0%	12%	12%	12%	12%	12%
Colombia	6%	0%	6%	6%	6%	0%
China	8%	8%	0%	8%	8%	8%
UK	10%	10%	10%	0%	0%	10%
Germany	10%	10%	10%	0%	0%	10%
EEUU	15%	0%	5%	5%	5%	0%

For / From	Japan	Colombia	China	UK	Germany	EEUU
Japan	0.5	1.0	0.5	1.25	1.25	1.0
Colombia	1.0	0.5	1.0	1.0	1.0	0.5
China	0.5	1.5	0.5	1.0	1.0	1.0
UK	1.25	1.0	1.0	1.0	0.5	0.75
Germany	1.25	1.0	1.0	1.0	0.5	0.75
EEUU	1.0	0.5	1.0	1.0	0.75	0.5

Figure 8. Financial Report - tab 2

3.4. Data from tab 1 - Balance sheet

3.4.1. Balance sheet

- Cash and securities: Considered as cash, everything that can be immediately converted to money.
- Accounts receivable: Amounts owed to the company for products sold.
- Inventories: Value of stocks of the product that the company has in its warehouses or warehouses.
- Containers: Value of the containers the company has
- Plant and equipment: Value of tangible assets acquired, built or under construction, with the intention of using them in the manufacture of their products.
- Total assets: Assets that the company has. It is obtained from the sum of the fields cash and values + accounts receivable + inventories + containers + plant and equipment.
- Accounts payable: Represents the amount of money that the company owes to third parties.
- Taxes payable: Contributions established by law for the operation of the organization.
- Loans and interest: Loans that companies have with a financial entity.
- Retained earnings: Earnings that are not distributed by the partners, in order to capitalize the organization.
- Total liabilities and equity: It results from the sum of accounts payable + taxes payable + loans and interest + retained earnings.
- Dividends paid: Value of the profits that have been distributed among the partners.

3.4.2. Statement of income

- Total sales: Total income from product sales.
- Net Income: Earnings obtained in the period by the company.
- ROE (return on equity): Indicates the level of profits generated by each peso of property owned by the shareholders. It is obtained by dividing the net profit by the equity.

3.5. Data from tab 2 – rates

- Export tariffs: Similar to transportation traffic, however, export tariffs are applied to the profits of the company in each country, not to manufacturing costs.
- Transport rates: It expresses the cost of sending products from one country to another.

3.6. Data from tab 3 – Detailed Income Statement

- Sales: Income received from the sale of products in all countries.

- Cost of sales: Costs attributable to the production of the products.
- Gross profit: Profit before deducting operating expenses and taxes.
- Research and development: Amount of money to be invested in research and development for each product.
- Marketing expenses: Value corresponds to the marketing consultancy for the units sold.
- Import expenses: Value that corresponds to the taxes that the countries charge to be able to commercialize the products there.
- Transportation expenses: Costs to be assumed for container handling in the period. Here are considered costs such as internal transportation in each country, the loading and unloading of these.
- Marketing consulting: Value that corresponds to costs for marketing consulting in all countries.
- Production consulting: Value corresponding to the costs for the production consulting in the two plants.
- Insurance: Value invested in the purchase of insurance in that period.
- The Depreciation rate: Expenses for the depreciation of the plant and containers.
- Compensation: Amount of money that was used to give bonuses to employees for their good performance in the period.
- Plant sale loss: Indicates the value that represents the 25% loss that results from the sale or reduction of capacity of a factory.
- Loan amortization: Amount of money destined to pay the installment of the loan or loans that the company has.
- Capacity expansion: Represents the money invested for plant expansions.
- Product purchase: Amount of money spent on product purchase to meet customer demand and / or the minimum amount of inventory.
- Operating profit: Profit or profit before taxes.
- Taxes: Amount of money that must be paid to the government of the country where the company operates to obtain operating profits. To facilitate the handling of taxes, these are calculated with a rate of 21%.
- Net profit: Earnings obtained by the company in that period. (operating profit less taxes)
- ROE (return on equity): Indicates the level of profits.
- Dividend payment: Amount of money that was used to distribute among the partners.
- Insurance Information: Amount invested in the two types of insurance available, used in the period that ended.
- Loan amount: Amount of money the company is owing.
- Installment / month: Value per month that should be used to repay the loan.
- Nominal Interest and annual effective interest: Interest rates at which the loans were made.
- Level of indebtedness.

Business Simulator - Financial report

Balance sheet Tariffs **Income statements**

Income statements

Item	Value	Item	Value
Sales	23.904.730,28	INSURANCE	
Sales cost	8.740.424,70	Accident insurance	65.000
GROSS PROFIT	15.164.305,58	Liability insurance	65.000
Operating costs		Loans	
Investigation and development	2.495.000	Loan amount (initial + requested)	9.375.642
Marketing expenses	2.699.730	Fee / month	367.176,09
Import costs	1.690.716,67	Nominal interest	24,01%
Transportation expenses	416.869,50	Annual effective interest	26,83%
Marketing consulting	1.633.764,80	Debt level	46%
Production consulting	500.000		
Insurance	130.000		
Depreciation	179.970,35		
Compensations	0		
Loss sale capacity	0		
Repayment loan	1.101.528,27		
Capacity expansion	0		
Product purchase	3.677.648		
TOTAL OPERATION COSTS	9.746.053,75		
OPERATIONAL UTILITY	5.418.251,83		
Taxes	1.137.832,88		
NET PROFIT	4.280.418,95		
ROE	45,74%		
Dividend payment	0		

Figure 9. Financial Report - tab 3

4. Discussion and conclusions

Now, in the face of the permanent and necessary technical and technological development of companies, Industrial Engineers have been forced (and at the same time the opportunity) to expand their field of action to unimagined horizons. Therefore, it is essential that these professionals, in addition to the competence for the classic functions of Industrial Engineering, have a solid background in finance, mathematical models, occupational health, supply chains, among others.

The development of strategic competencies such as business vision, strategic thinking and financial analysis in the Industrial Engineering student are important for the full fulfillment of the mission, the achievement of the vision and to achieve the objectives outlined in the business. In this aspect, the challenges in education currently generate the need to design more and better methodologies, using all available resources, whether human or technological. In this way, many educational strategies have adopted learning models that make use of information technologies to reinforce the process of generating knowledge.

The Business Simulator is a useful instrument for the practical development of the academic knowledge acquired by students during their degree, since it teaches

how to think and act like a real administrator, who develops and implements skills to generate competitive advantages in different settings. By being part of the business simulation project, the student is expected to acquire a clearer vision of their role as a professional future, developing communication skills in business, teamwork, leadership and decision-making that would only be obtained with practice.

On the other hand, it is expected that the business simulator model presented will be a great learning tool for students, since it puts into practice the knowledge acquired during the degree program, streamlines the decision-making process, encourages multidisciplinary work as a team and teaches how to plan and implement strategies between the different departments of the organization. At the same time, working together with other departments acquires a more specific vision of the importance of decision-making, since it is learned that a decision affects, either positively or negatively, all areas of the company.

Finally, the study laid the theoretical and practical foundations for future research, which improve the model with the addition of new features focused on implementing smart organizations with the help of Artificial Intelligence, Machine Learning and Deep Learning algorithms, which optimize data processing.

and provide better support to the decision-making process.

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