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Evaluation of Economic Losses by the Presence of Deterioration of Metallic Materials of Medical Products, Analysis of Foreign Trade, Business Management and University Linkage in a Biomedical Industry of Tijuana

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Abstract - A microanalysis of the economic losses by the presence of the corrosion on metallic connections of medical products as the infusion systems with metallic cannulas fabricated in a biomedical industry located in Tijuana city. Also, was evaluated the foreign trade action, business management and the educative linkage with the industry of this relevant city of the northwest of the Mexican Republic. The action of foreign trade was evaluated regarding the obtaining of raw materials used in the manufacturing processes of the industrial company that allowed this research to be carried out, as well as the application of business management, as part of the planning, organization, focus and control of the resources of every industrial company. The main objective of business management is to achieve the objectives of the organization and obtain the most efficient results. In addition, the relationship between university education and the operational performance of workers who work in manufacturing areas was evaluated, to determine if the knowledge obtained by graduates of a prestigious university in this region of Mexico, which generates a large number of graduates of various university careers for the industries of this important city of our country. The results of this scientific study indicate that were necessary evaluate the four factors, which were having an effect in operative yielding of the workers of the manufacturing areas, with this, a negative effect in the economic losses of this industrial plant evaluated in the 2024.

Keywords: Economic losses, corrosion, medical products, foreign trade, business management, educative linkage with industry, operative yielding.

1. INTRODUCTION

In the manufacturing areas of any type of industry, various types of actions can occur that can affect the operational performance of workers working in industrial processes. Among the main aspects that can have a negative effect and can generate economic losses to industrial plants located in any country in the world, and which are the focus of this scientific study, are those listed below (Chaisumpunsakul et al, 2018):

a) Analysis of the deterioration of the electrical connections of medical products manufactured in the biomedical industry evaluated, due to the presence of atmospheric pollution (which includes air pollutants, such as sulfur dioxide (SO2), nitrogen oxides (NOX), carbon monoxide (CO) and chloride ions (Cl-); In addition to variations in climatic factors such as relative humidity (RH, %) and temperature (T, °C), they can generate aggressive environments in the areas of industrial processes).

b) Evaluation of foreign trade activities in our country, where in this research, the purchasing department analyzes the types and costs of raw materials to be used in manufacturing processes, which come from outside the Mexican Republic, because this industrial plant located in the city of Tijuana, is foreign with its headquarters in the city of Atlanta, Georgia, United States. This analysis is relevant, having been prepared from January to December 2024, and at present, once the new president of the United States of America (USA) entered office, the action of tariffs between Mexico and the United States was presented, even though they have had a Free Trade Agreement for more than 20 years. In this way, continuous improvement activities can be generated to achieve savings in manufacturing processes, with innovation and technology actions by specialized engineering personnel in industrial processes, to compensate for the situation of the presence of tariffs, which affects both the obtaining of raw materials for this evaluated industry and the products manufactured in this industrial company, where most of the manufactured products are marketed in the United States.

c) Analysis of business management, which indicates the way in which planning, organization and control actions of the functions in each area of an industrial company are evaluated, where in this industry, the focus was on the proper management of economic, human and material resources, which lead to their optimal use and thus to obtain the maximum economic profits from this evaluated industry. These actions were developed and supervised by expert accounting, administration and engineering personnel of the industrial plant that allowed this scientific study.

d) An evaluation of the operational performance of young workers represented by recent graduates of a prestigious university in this important city in northwestern Mexico was developed, to correlate the educational programs of this university with the operational performance, indicating that the recently graduated students would perform their functions appropriately, without making too many mistakes, like a worker who did not attend this university or was not a student at any other school with a university degree.

The four relevant aspects evaluated in this investigation is represented in figure 1 (Hama J, et al, 2017).

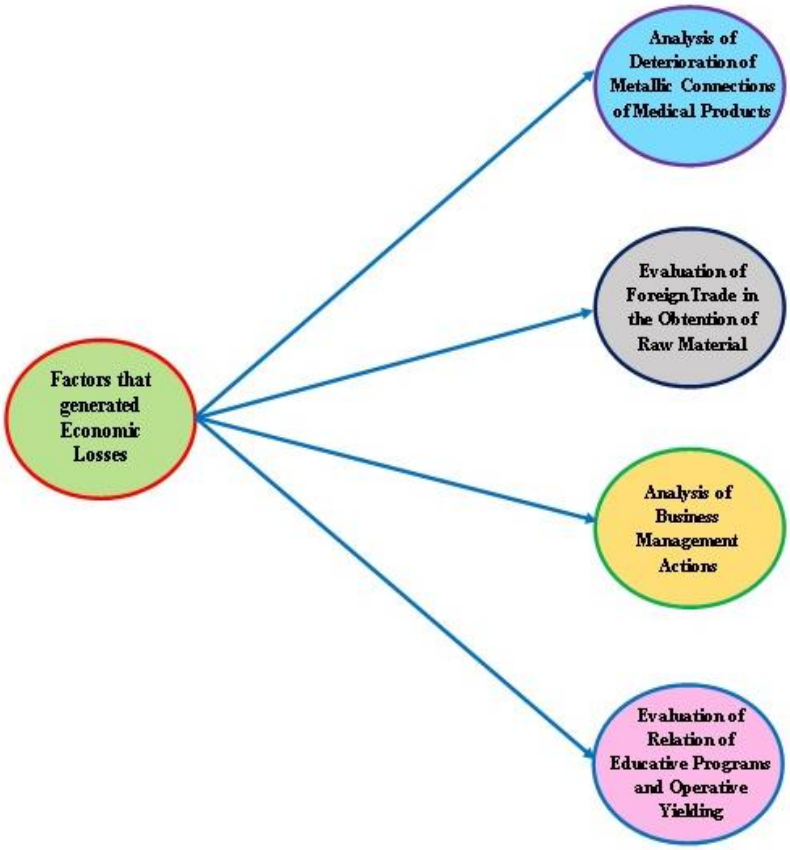

Fig -1: Relevant aspects evaluated in the investigation
Source. Analysis of investigation

1.1 Biomedical Industry in Tijuana

Is a relevant industry at the worldwide where are manufactured a lot medical products utilized in the daily activities, especially in health clinic, hospitals, pharmaceutic stores and other types of commercial centers and stores. The ten principal medical products fabricated in the biomedical industry located in the Tijuana city, are described in table 1 (AIMT, 2024).

Table -1: Evaluation of biomedical products manufactured in the biomedical industry located in Tijuana (2024)

Relevant Parameters / Medical Products	Manufacturing Cost	Commercial Cost	Functionability
Cardiac Defibrillators	Almost $750 dlls/each one	Almost $1,000 dlls/each one	Evaluates the heart rhythm and if is necessary sends an electric shock to normalize it
Face Masks	Average $0.05 dlls/each one	Average $0.10 dlls/each one	Can filter the germs that are inhaled or exhaled by persons
Heart Valves	Around 3,500 dlls/each one	Around 5,000 dlls/each one	Can control blood flow in the heart and prevent it from flowing back
Infusion Devices Set	Almost 40.00 dlls/each one	Almost $50.00 dlls/each one	Utilized to administrate medicines, medical fluids, and nutrients to patients
Insulin pumps	Average $3,500 dlls/each one	Average $5,000 dlls/each one and 1,500 dlls/each one infusion equipment and reservoirs	Administers insulin continuously through a catheter
Intraocular Lenses	Around 1$1,650 dlls/each one eye	Around 2,000 dlls/each one	Implanted in each eye, is used to replace the natural lens of the eye
Oximeters	Almost $ 35 dlls/each one	Almost $50 dlls/each one	Measures the amount of oxygen in the blood, without the need to an internal action
Pacemakers	Average 3,000 dlls/each one	Average 4,000 dlls/each one	Utilized to support the control heart rhythm, sending electrical to impulses the heart function
Sterilizers	Around $700 dlls/each one	Around 1,000 dlls/each one	
Surgical Gloves	Almost $8 dlls/each one	Almost $15 dlls/each one	Used by surgeons to protect their hands from contaminants and reduce the risk of transmitting microbes

Source: Analysis of the investigation

Table 1 shows the information of the ten essential medical products fabricated in biomedical of the Tijuana city, with the manufacturing cost, commercial cost and this functionability; presenting the cost in dollars (dlls), which was obtained by interviews in 50 biomedical industries of this relevant city of Mexico in the 2024 year, which was the period of this scientific study (Sekwaila C., et al, 2020).

1.2 Microevaluation of Corrosion

Is an action to detect at microscale the deterioration of metallic connections of medical products fabricated, as was elaborated in this scientific study with a specialized instrument and technique called the Scanning Electron Microscopy (SEM). This part of this investigation was supported by an external company of specialized services in physicochemical analysis; being important in the results of this evaluation in the industrial plant that allow the realization of the scientific study. In the section of results appears some microanalysis of the deterioration of metallic connections of medical products manufactured in this electronics industry, by the bad handling of raw material, diverse materials, subproducts and final products (Abu Jadayil W. et al, 2017).

1.3 Business Management in the industrial processes

The actions of all managers of industries in any part of the world that supports to control the industrial activities, being important in the obtention of daily, weekly, monthly, seasonally and yearly goals (Asaolu O. et

al, 2017). The business management can develop some activities of specialized topics, as administration, finance, accounting, human Resources, marketing, industrial operations and logistics, to plan, organize and control of the industrial activities; to obtain the productivity and quality levels. A business manager is considered the principal manager of any industrial plant located in this important city, which debit be some qualities and characteristics, as is mentioned the next table 2 (Susan R. et al, 2023).

Table -2: Analysis of skills of business manager and his functions (2024)

Skills of Business Manager	Models of Business Management
a) Have leadership to determine the essential functions of each worker as administrative or productive operations.	a) Lean Manufacturing.
b) Be available to listen and communicate responsibilities appropriately	b) Management by Objectives
c) Have the capacity to solve any type of problems.	c) Business Canvas Method
d) Have the capacity to make good decisions.	d) Empowerment Model
e) Have great knowledges of all industrial operations: administrative and industrial processes.	e) Six Sigma Approach
f) Understand about the marketing actions about the trends about the products manufactured in each industrial company in the world.	f) Specialize marketing strategies
g) Detect and determine the essential customer needs, and suppliers of the raw materials and subproducts.	g) Specialized customer strategies

Source: Analysis of the investigation

A business management debit be a specialized person, which can be have the capacity to actualize his knowledges and strategies, about the actual technologies and the needs of the customers all seasons and years.

1.4 Relationship between programs of universities and industrial operative yielding

The development of professional practices is a relevant factor in the training of human resources of students at educational levels where it is required to develop them, to reinforce the skills, abilities, aptitudes, attitude and behavior of students, who have acquired the knowledge of their respective topics of their professional careers Dhafr N. et al, 2016)). At the university and high school level, these types of educational processes are considered, where at the university level, it is encouraged with greater intensity, with the objective of reinforcing the integral development of students, considering this activity as human resource training. This is part of a concern to know the impact that the development of professional practices can generate on the part of the student population of a university located in the city of Tijuana (Lizeth Abigail Figueroa Corral et al, 2023). This university is recognized nationally and internationally, currently being number 1 in the northwest area of the Mexican Republic, the sixth best university nationally and the 71st in Latin America, training professionals who carry out their functions efficiently (Del Vecchio P. et al, .2022)), and is linked to the commercial and industrial productive sector of this city.

2. METHODOLOGY

This investigation was made to determine the factor that caused the more negative effect in the evaluation of the economic losses in the biomedical industry where this scientific study was made, elaborating the next activities:

a) Evaluation of the deterioration of the metallic connections of the medical products fabricated in the biomedical industry where this scientific study was made.

b) Analysis of the raw material with foreign trade to obtain of the United States, to be used in the manufacturing areas of this biomedical industry.

c) Evaluation of the specialized strategies of business management applied in this investigation.

d) Analysis of the correlation of educative programs of a prestigious university of this city and the operative yielding of workers of industrial processes.

3. RESULTS

With this investigation relevant information was obtained to be evaluated and presented in the next sections, to determine the principal parameter that causes the economic losses.

3.1 Analysis of deterioration of the metallic connections

In this investigation, was made a microanalysis of the deterioration of metallic connections of a biomedical product manufactured, which was generated electrical failures and with this was a defective product fabricated in this biomedical, where was made this scientific study. This biomedical product is a pacemaker that was elaborated bad functions in the test of the quality actions, and was not realized the adequate operation. Figure 2 shows the electrical connection of the power supply of the pacemaker, illustrating the dark zones the deterioration of the electrical connections in both microphotographs. The scale was at 100 micra of size of the microanalysis.

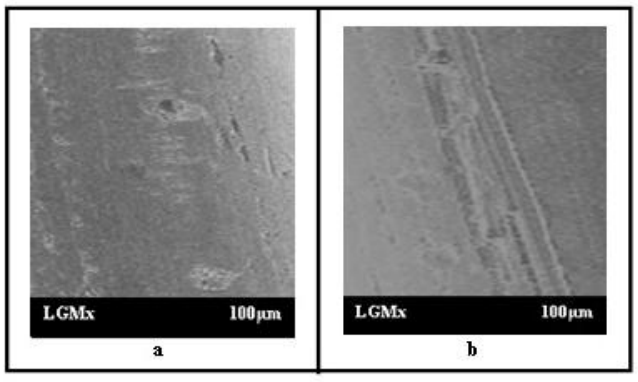

Fig -2: Microanalysis of the deteriorate metallic connections of medical products

Source: Analysis of investigation

3.2 Evaluation of raw material with foreign trade

This part of the investigation consisted of the evaluation to obtain the adequate raw material of this biomedical industry that allow the realization of this scientific study. The actions to obtain the correct raw

material, were the by searching for materials in various industrial companies that manufacture various types of materials for the biomedical industry (Chioma A. et al, 2018). This is important because, based on this search, it is possible to obtain suppliers at the lowest cost, materials with optimal performance and, above all, those that are as close to the industrial company as possible, which in this case is in the biomedical sector, where this scientific study was made. Based on the information describe above in this part of the investigation, was made a specialized analysis about to obtain the raw material and be evaluated to obtain very quickly, or determine the principal obstacles to obtain the raw material utilized in the manufacturing areas to fabricate the biomedical products in this biomedical industry, and is represented in table 3

Table -3: Evaluation of foreign trade and manufacturing parameters (2024)

Period of Analysis	Materials								Manufacturing Parameters			
	CM, %		IM, %		SPOM, %		LPOM, %		Productivity, %		Quality, %	
Months	BI	AI	BI	AI	BI	AI	BI	AI	BI	AI	BI	AI
January	67	89	76	34	56	32	67	44	67	88	68	90
February	62	92	84	32	58	33	69	40	65	85	64	87
March	60	91	80	33	54	30	70	41	68	80	65	91
April	64	96	83	31	55	28	68	40	62	84	60	88
May	62	90	80	30	53	30	69	38	64	89	62	85
June	60	88	86	26	51	34	61	34	62	91	58	87
July	66	93	87	25	50	27	60	31	63	90	62	90
August	62	95	79	22	49	22	58	28	64	88	59	88
September	68	97	83	24	48	24	56	29	65	90	63	91
October	70	97	80	27	53	25	55	27	62	87	66	90
November	72	98	83	25	50	22	54	25	65	93	63	94
December	71	98	77	20	49	21	55	26	63	90	60	91

CM. Correct Material; IM. Incorrect Material; SPOM. Short Period of Obtaining Materials; LPOM. Long Period of Obtaining Materials; B.I. Before the Investigation; AI. After the Investigation.

Source: Analysis of the investigation

Table 3 shows the relation between manufacturing parameters and foreign trade to obtain the raw materials, illustrating the improvement of the analysis of this part of the investigation, observing that after the evaluation, the factors analyzed as monthly periods were increased.

3.3 Analysis of business management strategies

The analysis of this relevant thematic generated interesting information that was used to elaborate the continuous improvement and have better operative yielding of the workers of the manufacturing areas, which originated economical gains, and is presented in table 4. This evaluation consisted in analyze the business management strategies is very important, because can determine the type of event in each critical situation that can be elaborate each continuous improvement, in every case of the manufacturing areas. For this reason, is necessary evaluate the specialized business management strategies to generate the actions

of planning, organization and control of the industrial operations in each manufacturing areas of this biomedical industry, where was made this scientific study, and is expressed in table 4. This table represents the relation between the actions before and after the investigation to generates the results in the productivity and quality indices, and observe the results in each manufacturing processes evaluated, as is presented in table 4.

Table -4: Analysis of business management strategies and manufacturing parameters (2024)

Period of Evaluated	Productivity %		Quality, %	
Months	BI	AI	BI	AI
January	69	90	76	95
February	71	93	71	90
March	70	89	73	92
April	70	88	70	93
May	74	94	69	88
June	72	90	73	90
July	70	90	75	92
August	68	85	76	96
September	73	90	72	90
October	74	92	74	89
November	72	89	75	92
December	70	93	73	90

BI. Before the improvement (in January, 2024), AI. After the improvement (in December, 2024)

Source: Analysis of the investigation

3.4 Correlation analysis educative programs and operative yielding

This analysis was made to relate the educative programs of a prestigious university o the Tijuana city, and the operative yielding of the workers as graduated or students that will be finish in a few period their university studies, to evaluate the necessity of improvements about the university programs or the strategies utilized in the manufacturing lines. This is very important because, in base at the described information about, can be elaborated determine the adequate continuous improvement actions to improve each industrial process of this biomedical industry that allow the realization of this scientific study. This is presented in table 5, where observed the increments of the productivity and quality levels in the manufacturing areas, where was made this scientific study, in the biomedical industry that allow this investigation.

Table -5: Correlation analysis of the educative programs and operative yielding (2024)

Factors Evaluated	Productivity %		Quality, %	
Months	BI	AI	BI	AI
January	54	93	57	97
February	49	90	58	94
March	56	94	60	93
April	58	92	61	97
May	56	90	59	94
June	59	95	62	90
July	60	94	63	98
August	62	92	61	95
September	59	91	59	96
October	62	93	62	94
November	58	90	67	92
December	60	93	69	97

BI. Before of the improvement (in January 2024), AI. After the improvement (in December, 2024)

Source: Analysis of the investigation

4. CONCLUSIONS

This investigation was made to evaluate the principal factors that can be analyzed to improve the manufacturing processes, to determine the positive and negative effect on the productivity and quality levels. Also, was made this scientific study, to have the opportunity to improve each industrial processes, being presented as the operative yielding, and the improve of the specialized strategies of the planning, organization and control, of the industrial processes, where in this investigation, the application of the continuous improvement, improved the industrial activities, and with this, the productivity and quality indices, and of this way, this biomedical industry, was presented the economic gains.

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