Proposal of a Production Management Model for small tanneries applying Good Manufacturing Practices

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Abstract

The small tanneries in Arequipa are traditional companies tending to disappear due to environmental and competition problems. In order to survive, they need to become more technical and apply models that allow production within the environmental standards required by government agencies and a better application of their resources to make their production profitable and be competent. The proposed management model applying Good Manufacturing Practices allows to systematize the control of processes and their continuous improvement, without representative costs that may be within the reach of a small tannery. With its implementation it will be possible to identify and reduce the waste of resources and the consumption of inputs.

Keywords
Tannery, production management model, good manufacturing practices, business project management.

1. Introduction

Peru is a country with an important tradition in the animal skin tanning industry, there are important companies and brands of products based on natural leather that have international positioning, but this industry has not managed to develop technologically, because it is going through a of its worst crises; mainly due to external factors of the environment of the leather industry, such as high competitiveness, alternative products and environmental requirements. In this analysis there are also internal factors, which remain over time and do not allow the necessary changes for their development, for which it is necessary to intervene, so that they can subsist and develop. In Figure1 you can see how the works are currently being developed, in a very traditional way.
Micro and small companies in the tannery sector have been characterized by empiricism in the management of their operational processes and uncontrolled levels of environmental pollution, which in turn cause low productivity and a bad image. These companies have developed empirical processes over the years, in which measurements, records or tests are not carried out, this limits continuous improvement, makes it impossible for companies to analyze their processes and effectively measure their results. Figure 2 shows the transport of leather belonging to a small tannery, in an unconventional way.

Figure 1: Tanning work

Figure 2: Leather transport

The production processes used maintain high levels of waste, defects in the dosage of inputs in each of its processes, high level of reprocessing, inadequate distribution of work, lack of records and production documents causing low productivity, directly affecting its profit margin. In Figure 3 it clearly presents all the actors involved in the tannery sector in Arequipa.

As already mentioned, the leather industry in Peru is in critical condition due to the presence of internal and external forces, the formal tanneries are forced to close and the workers reappear in the market creating informal tanneries. Many formal tanneries even rent out their services to informal tanners as a means of generating income (Mera 2010). Formal tanneries, once far from residential areas, are now surrounded by houses. Residents are outraged by untreated effluents and solid waste without proper disposal creates bad odors. Many informal tanners operate within their own homes, surrounded by their neighbors who suffer the consequences (Mera 2010)

Globalization will continue to make Peru's leather and footwear industry vulnerable to attack by cheap imported shoes, which may cause the number of formal tanners to continue to decline. The availability of cheaper leather shoes from other countries has also depressed the demand for Peruvian leather and footwear (Mera 2010).

According to estimates by the Research and Development team of CITEccal Lima, tanneries in Peru produce 536 tons of leather shavings annually, which would represent 13.4 tons of chromium that would be wasted and would end up exposed in the environment. Leather shavings contain chromium in a harmless but potentially harmful state, since an inadequate final disposal promotes its oxidation to chromium VI, a carcinogenic and polluting substance (Technological Institute of Production ITP red CITE).

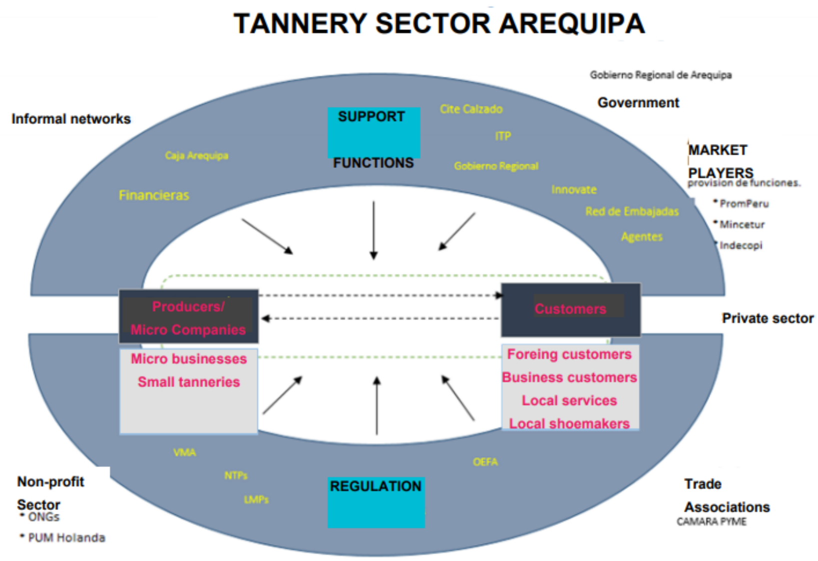

Figure 3. Matrix of Actors-Arequipa Tannery Sector. Source: (HelvetasSwissIntercoperation Peru)

1.1 Objectives

Propose a Production Management Model to improve the competitiveness of small tanneries, based on Good Manufacturing Practices GMP and on an information system for the dosage of tanning supplies.
Being an essential part of caring for the environment, the present work should design a model that can adjust the parameters of the processes involved in leather production to improve effluent quality. The inputs of each sub-process must be continuously adjusted to see how this is reflected in the outputs and the effect it will have on the consequent sub-process, with their corresponding records for continuous improvement of the process.
The processes that will be taken into account in this work are the following:

SOAKED

CHEMICAL INPUTS + WATER +SKINS
=
EFFLUENT QUALITY + SOLID WASTE + SOAKED SKINS + LEATHER QUALITY + COSTS

PEELED

CHEMICAL INPUTS + WATER + SOAKED SKINS
=
EFFLUENT QUALITY + SOLID WASTE + PEELED SKINS + LEATHER QUALITY + COSTS

TANNED

CHEMICAL INPUTS + WATER + PEELED SKINS
=
EFFLUENT QUALITY + TANNED SKINS + LEATHER QUALITY + COSTS

OILED

CHEMICAL INPUTS + WATER + TANNED SKINS
=
EFFLUENT QUALITY + OILED SKINS + LEATHER QUALITY + COSTS

DYED

CHEMICAL INPUTS + WATER + OILED SKINS
=
EFFLUENT QUALITY + FINISHED SKINS + LEATHER QUALITY + COSTS

2. Theoretical Review

Before defining the project, we will consider some definitions to take into account:
A production management model is "the process that guarantees the viability of companies through a form or logic of thought through which directors or managers have the ability to endure in the market in a sustainable way and with a tendency to grow. through the combination of the resources, it has"(Botero 2013) and is defined "as the strengthening of the production process in order to optimize its levels of competitiveness in the current market and also go in search of new markets"(Gallo and Patarroyo 2016).
The antecedents go back to 1906, in the United States, when the Federal Food & Drugs Act (FDA) was created. Later, in 1938, the Food, Drugs and Cosmetics Act was enacted, where the concept of safety was introduced. The decisive episode, however, took place on July 4, 1962, when the side effects of a drug were known, a fact that motivated the Kefauver-Harris amendment and the creation of the first guide to good manufacturing practices. This guide was subjected to various modifications and revisions until the regulations currently in force in the United States for good food manufacturing practices were reached, which can be found in Title 21 of the Code of Federal Regulations (CFR), Part 110. Good manufacturing practices "is a basic tool for obtaining safe products for human use, which focus on hygiene and handling. (Garimella et al. 2011). Diaz and Uría (2009) stated that Good Manufacturing Practices are a set of principles and technical recommendations that are applied in food processing to guarantee its safety and suitability, and to avoid its adulteration. Historically, Good Manufacturing Practices arose in response to serious events related to the lack of safety, purity and efficacy of foods and drugs.
Diaz and Saavedra (2012) say that GMP is the support that demonstrates the safety and quality of the products that are processed in a company, through which it is confirmed or assured that the products are consistently controlled and produced with quality standards, appropriate for their use planned and as required for its commercialization.
Good Manufacturing Practices are a set of operating instructions and operational procedures that allow to improve processes, anticipate and control the occurrence of contamination hazards. The implementation of GMP is a basic tool for obtaining safe products for human use, which focus on hygiene and handling.
"Competitiveness is a meaningless word when applied to national economies. And the obsession with competitiveness is both wrong and dangerous." (Krugman 1994). Increased Competitiveness is defined as "the result of the interweaving of a series of economic, geographical, social and political factors that make up the structural basis for the development of a nation." (Araoz 1998) is also said to be "The ability to sustain and increase participation in international markets, with a parallel rise in the standard of living of the population. The only solid way to achieve this is based on increased productivity" (Porter 1990), to "maintain a market share, with a product positioning, and this has the preference and satisfies the wishes and needs of customers." (Chávez el al. 2007) but the company also requires a competitive environment, which is achieved through mesoeconomic policies to modernize the factors. (ECLAC 1996).
Productivity is the "Relationship between production and the means used to achieve it." (Early 1905). "Quotient obtained by dividing production by one of the production factors" (OCCE 1950). "Change in the product obtained by spent resources" (Davis 1955). Productivity is a measure of how efficiently we use our labor and capital to produce economic value. High productivity implies that a lot of economic value can be produced with little work or little capital. An increase in productivity means that more can be produced with the same. In economic terms, productivity is all growth in production that is not explained by increases in labor, capital, or any other intermediate input used to produce. (Galindo and Ríos 2015) The economist Levy, S. (2004) insists that knowledge and its various expressions

are essential elements to raise levels of productivity and competitiveness and expand the productive sectors of a country, hence the importance of investing in science and technology.
In order to find a solution, the problem must first be established, “In reality, posing the problem is nothing more than refining and structuring the research idea more formally. The passage from the idea to the problem statement can sometimes be immediate, almost automatic, or take a considerable amount of time” (Hernández et al. 2014). Ackoff (1967) points out, “a correctly posed problem is partially solved, the greater the accuracy, the greater the chances of obtaining a satisfactory solution”.
An Information Systems "It is a process where there is an input, storage, processing and output of aggregated information" (Alvear and Ronda 2005).

3. Method

In the implementation of the production management model for small tanneries, based on the Good Manufacturing Practices model, the following steps must be followed:

Step 1: Address of the organization. Strategic plan.
Step 2: Align the processes of the organization. Macro processes aligned with customer value.
Step 3: Design the processes. Management by BPM Processes.
Step 4: Good Manufacturing Practices.
Step 5: Systematize and automate the registration and analysis of information.

In Figure 4 the proposed production management model has been outlined. Once the decision has been made by the owner of the small tannery to apply this model, a Strategic Plan must be developed, which will lead to some changes in its administrative and technological processes, which must be implemented with adequate training and above all with a commitment on the part of all those involved in order to achieve the objectives set. In this first step, the mission, vision, policies, values and strategic objectives that will govern the company must be developed. This strategic plan must be backed by an economic-financial, strategic and organizational plan that is capable of achieving the proposed objectives.

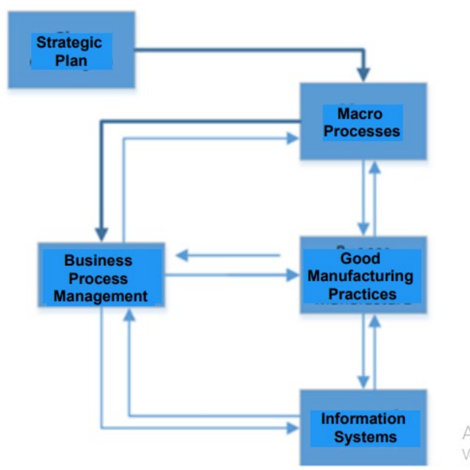

Figure 4: Production Management Model

One of the most complicated tasks is to collect the information of the processes that were developed, in some cases these were inherited from parents to children and recorded in notebooks with the fear of making changes, which could cause them losses. In the analysis of the processes, the results expected by external and internal clients must be taken into account in such a way that environmental policies are complied with and competitive products for the market are obtained. For the design of the processes, Business Process Management (BPM) was used as a methodology that integrates the strategy and objectives of the organization with the expectations and needs of the clients, with the possibility of implementing business software tools. In the Figure 5 shows the proposed methodology, where once the process is established, it will be fed back with the contribution of Good Manufacturing Practices and the Information System, to establish a continuous improvement in the processes, which allow best results.

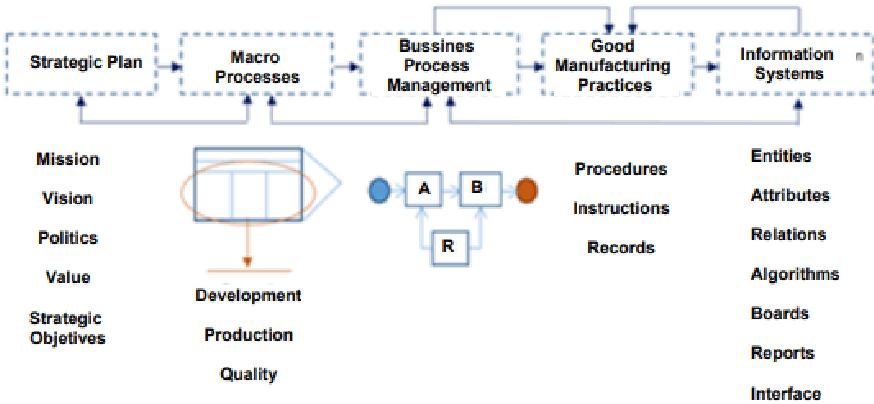

Figure 5: Proposed Methodology

The development of the processes will be carried out applying the methodology of Good Manufacturing Practices, establishing Procedures, Instructions and Records, which standardize the practices and are improved with the information that will now be registered, as shown in Figure 6. The operator must comply with the technical sheet and in the event that any variation is made, this must necessarily be recorded, not only in the actions that were carried out but also in the inputs, in the final product and in the effluents.

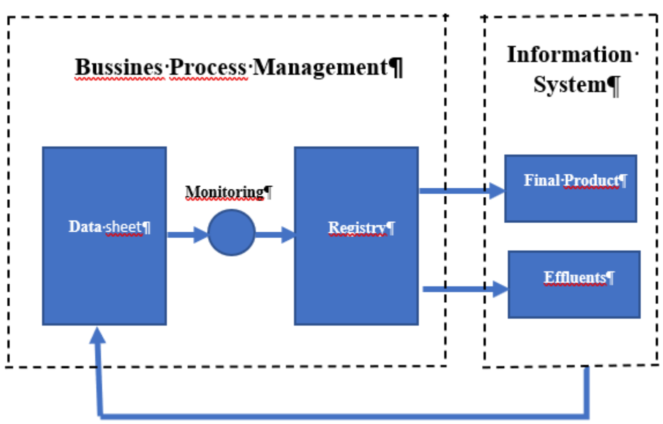

Figure 6: Production Management Model

The last step is to implement an Information System that allows the recording and analysis of the information. As shown in Figure 5, the parameters that this easy-to-use and low-cost information system will handle must be established, which is available to these small companies.
With this model it is possible to reduce the percentage of deficiencies and gaps in leather production, proposing a better use of resources and reduction of environmental impacts, for which procedures, instructions and records will be used for each sub-process. To apply this model, the current processes must be aligned with those proposed, going through a periodic documentary review which will serve to carry out continuous improvement.
To start the implementation of the Good Manufacturing Practices methodology in leather tanning companies, the main problems must be diagnosed within the activities that are carried out, both at an administrative and operational level, and which will be applied to the following processes:
A. Formation of a BPM committee

- Objectives
- Responsibilities
- Election of committee members
- Installation for the first and subsequent meetings

- Committee functions

B. Documentary control
- Objectives
- Document relation (Procedures, instructions and records)

C. Conservation and storage
- Procedure (code, objective, description and responsible)
- Instructions (Code, instructions, tools and security measures)
- Records (entry of raw material, warehouse environmental conditions and weekly inventory)

D. Transportation and handling of raw materials
- Procedure (code, objective, description and responsible)
- Instructions (Code, instructions, tools and security measures)
- Records (Raw material order)

E. Procedure for generating tokens
- Warehouse data entry
- On-site process
- Product quality by process
- Environmental aspects by process

F. Production
- Soak (procedure, instructions and registration)
- Peeled (procedure, instructions and registration)
- Tanning (procedure, instructions and registration)
- Lubrication (procedure, instructions and registration)
- Tincture (procedure, instructions and registration)

G. Quality
- Leather quality by process (procedure, instructions and registration)
- Environmental quality control (procedure, instructions and registration)

All these processes must be duly registered, according to the previously established formats, where the process, the date, the person who approved it and to which revision it corresponds is necessarily registered.
The company will maintain the system through internal audits which will be carried out at least twice a year in all processes in order to verify, control and maintain the implementation according to the planned conditions in the requirements of Good Manufacturing Practices and quality controls of the company (Vargas 2014). These audits must be carried out fulfilling the following tasks:
- Objective
- Internal audit process
- Internal audit benefit
- What would be verified in the audit
- Internal audit report

5. Results and Discussion

The proposed method was implementation was a carried out in the tannery located in the Rio Seco Industrial Park in the city of Arequipa, obtaining interesting results in the first year of its implementation. The Table 1 shows the consumption of inputs in the peeling, tanning and dyeing processes without having implemented Good Manufacturing Practices, and in the figure 7 you can see the amount of residual water that is produced in the different processes carried out,
In the Table 2 shows the consumption of inputs after implementing Good Manufacturing Practices. and in the Figure 8 you can see the amount of residual water with GMP implementation. In the Figure 9 shows the use of supplies in the Peeled, Tanned and Dyed processes before and after of GMP implementation

Table 1: Consumption of inputs in the Peeled, Tanned and Dyed processes. Process without GMP implementation

	Input	Quantity	Process	Output		
Soaked	Water	2.40 m^3/lot	**Peeled**	Residual Water	2.20 m^3/lot	Sulfides, lime, organic material, hairs.
	Sodium Sulfide	2.00 Kg/lot				
	Lime	2.50 Kg/lot				
Tanned	Water	2.00 m^3/lot	**Tanned**	Residual Water	1.80 m^3/lot	Chromium salts, acids.
	Chromium salts	1.05 Kg/lot				
	Basifying	0.35 Kg/lot				
	Dyes	0.70 Kg/lot				
Post tanned	Oils	2.10 Lt./lot	**Dyed**	Residual Water	2.80 m^3/lot	Dyes, oils
	Water	3.00 m^3/lot				
	Formic acid	0.70 Kg/lot				

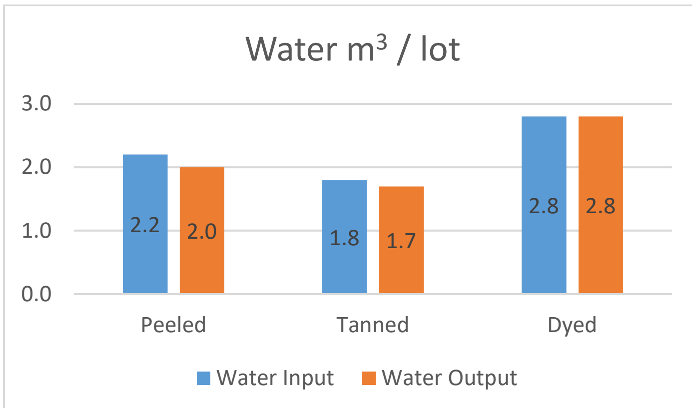

Figure 7: Residual Water in the Peeled, Tanned and Dyed processes. Process without GMP implementation

Table 2: Consumption of inputs in the Peeled, Tanned and Dyed processes. Process with GMP implementation

	Input	Quantity	Process	Output		
Soaked	Water	2.20 m^3/lot	**Peeled**	Residual Water	2.00 m^3/lot	Sulfides, lime, organic material, hairs.
	Sodium Sulfide	1.80 Kg/lot				
	Lime	1.90 Kg/lot				
Tanned	Water	1.90 m^3/lot	**Tanned**	Residual Water	1.70 m^3/lot	Chromium salts, acids.
	Chromium salts	0.97 Kg/lot				
	Basifying	0.31 Kg/lot				
	Dyes	0.62 Kg/lot				
Post tanned	Oils	2.10 Lt./lot	**Dyed**	Residual Water	2.80 m^3/lot	Dyes, oils
	Water	3.00 m^3/lot				
	Formic acid	0.58 Kg/lot				

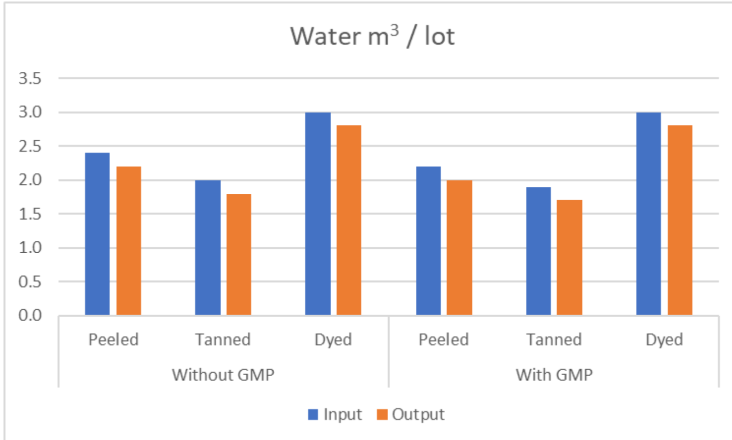

Figure 8: Residual Water in the Peeled, Tanned and Dyed processes. Process with GMP implementation

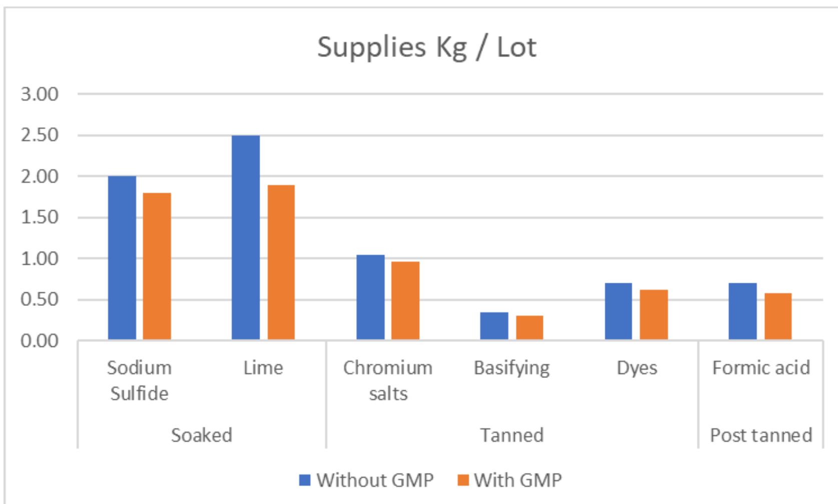

Figure 9: Use of supplies in the Peeled, Tanned and Dyed processes before and after of GMP implementation

This analysis shows a reduction in water consumption by 4% per piece produced and in the consumption of inputs in the leather and tanning processes by 15%, which will give better results in its economic situation and environmental impact.

To analyze the results in the Competitiveness dimension, an analysis was made of the costs per lot produced for a sample of 108 lots. The result obtained is detailed in Table 3, in which the Costs per Lot of the inputs in the corresponding processes and the Total Cost have been evaluated in soles (S /.). In this Table it can be seen that there is a cost reduction in all processes, the most important being that of the soaked process, and in the total cost of production it is 12%.

Table 3: Production costs per lot

Indicator	Input Value	Output Value	Variation	Percentage
Cost of Supplies Peeled	332	290	-42	-13%
Cost of Supplies Tanning	222	212	-10	-5%
Cost of supplies Dyed	190	180	-10	-5%
Total Cost	1122	990	-132	-12%

To evaluate the environmental impact, an analysis of the wastewater was carried out, to compare the values of the polluting elements before and after implementing Good Manufacturing Practices. In the measurements, the degree of acidity or basicity of the aqueous solution (pH), the thermal degree (Temperature), the portion of retained solids (Suspended solids), the concentration of sulfides (Sulfides), the amount of oxygen and the degree of residual load (BOD5) and degree of contamination (COD).
Table N 4 details the results of the analysis carried out, where it is verified that the wastewater that comes out after applying the GMP processes contains fewer polluting elements, which reflects a better result in the environmental impact, which makes the product more competitive, especially in the international market

Table 4: Analysis of contaminants elements

Indicator	Unit	Before BPM	Later BPM	Variation	Percentage
pH	-	13	10	-3	-23%
Temperature	°C	20	25	5	25%
Suspended solids	mg/L	12220	7723	-4497	-37%
Sulfides	mg/L	1619	892	-727	-45%
DBO5	mg/L	9510	3980	-5530	-58%
DQO	mg/L	14900	7865	-7035	-47%

The evaluated Management Model complies with the improvement of productivity and competitiveness indicators, which will have better results if an information system for the dosage and impact of tanning inputs is implemented.

6. Conclusion

The planning, implementation and maintenance of the Good Manufacturing Practices system allows the processes to be aligned and to begin to reduce the inputs according to the results of skin quality control and environmental quality control. The implementation of the Production Management Model is very low cost and brings with it improvements in productivity and competitiveness of the company, giving it a place in the tannery market, strengthening itself against its external and internal clients.
With this model, the standardization of processes can be achieved, which can be standardized in all small tanneries that seek the same product quality. The inclusion of a system of Good Manufacturing Practices aligns the company to an international quality system which can be certified.
At present, small tanneries, in order to continue with their operations, must have environmental management instruments (IGA), where real and potential impacts are recorded; and improvement projects are proposed, which are required by the Ministry of the Environment through the OEFA and by the Ministry of Production through the Directorate of the Environment. This work proposes an information system for the dosage that will contribute in the support of your improvement projects.

References

Araoz, M., *La Integración Como instrumento para incrementar la Competitividad en un mundo globalizado: perspectivas en la Comunidad Andina*, CEFIR, Montevideo, Uruguay, 1998.
Alvear, T., Ronda, C., *Un apoyo a la gestión empresarial*, Universidad de Chile, Chile, 2005
Ackoff, R., *Un concepto de planeacion de empresas*, Limusa, Mexico, 1997.
Botero, S., *Sistema de Gestion de Produccion para la empresa SCARPA calzado original en la ciudad de Bogotá, Colombia*, Universidad EAN, Colombia, 2013.
Chávez, J., Bonales, J., Sanchez, G., *Competitividad de las empresas que exportan fresa a los Estados Unidos de América del Estado de Michoacán, México*, Consejo Iberopanamericano de Administracion, Mexico, 2007.
Diaz, A., Uria, R., *Buenas Prácticas de Manufactura, Una guía para pequeños y medianos agroempresarios*, Instituto Interamericano de Cooperación para la Agricultura (IICA), San Jose, Costa Rica, 2009.
Diaz, M., Saavedra, S., *Documentación de las Buenas Prácticas de Manufactura (BPM) en la Empresa Derivados de fruta LTDA según decreto 3075 de 1997*, Universidad Tecnológica de Pereira, Colombia, 2012
Galindo, M., Ríos, V., *Productividad, Serie de Estudios Económicos*, Vol. 1, México, 2015.

Gallo, J., Patarroyo, W., *Diseño de un Modelo de Gestión de la Producción en la Empresa Induplas S.A.*, Universidad Sergio Arboleda, Colombia, 2016.

Garimella, K., Lees, M., Williams, B., *Introduccion a Buenas Practicas de Manufactura para Dummies*, Wiley Publishing, Inc., USA, 2008.

Hernandez, R., Fernandez, C., Baptista M., *Metodologia de la Investigacion*, 6^{rd} Edition, Mc Graw Hill Education, Mexico, 2014.

Krugman, P., *Competitiveness: A Dangerous Obsession*, Foreign Affairs, 73, No. 2, Marzo/Abril, pp. 28-44, USA, 1994.

Levy, S., *Ensayos sobre el Desarrollo Económico y Social de México*, Fondo de Cultura Económica, México, 2004.

Mera Rivera, *Gestión Ambiental para minimizar la contaminación generada por la industria de curtiembre en el distrito de El Porvenir*, Universidad Nacional de Trujillo, Peru, 2010.

Porter, M. The Competitive Advantage of Nations. The Free Press. USA, 1990

Vargas, A., *Analisis de implementacion de Buenas Practicas de Mercadeo y Manufactura para el desarrollo de las exportaciones a Belgica en un MYPE Textil*, Universidad Catolica de Santa Maria, Peru, 2014.

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