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The effect of production costs on the provisioning management of materials: Evidence from paper industry in Peru

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A B S T R A C T

This paper presents an empirical investigation to evaluate the impact of purchase, storage and inventory management on the production costs of materials supply management in the Peruvian paper industry. A linear regression model was used under the ordinary least squares method to determine the causal relationship between the provisioning of materials and production costs. It was concluded that the evaluation of the effect between the study variables was inversely proportional, that is, as the management of purchase, storage, and inventory in companies improve, the production costs may also be reduced.

1. Introduction

The provisioning of materials is a concept linked to the logistics of a company and according to Tang (2018) logistics is a concept designed to meet the client's requirements, which is the basis of the productive activities of any organization. Today, there is still unknown for its correct management: on the one hand, the correct inventory is the value that many people are trying to achieve after balancing the initial demand and supply. In today's market with rapid globalization under the effect of information and communication technologies, logistics is becoming a new factor of competitive differentiation. Even in the local market, companies located in remote areas, supported by high-quality logistics, have experienced significant increases in production and competition related to services. Therefore, having good logistics can not only reach distant markets competitively, but also maintains and improves the competitiveness of the local market. In this case, the company must develop logistics to not only ensure a higher level of competitiveness, but also to maintain competitiveness.

For this reason, Candas and Kutanoglu (2020) indicated that logistics today constitutes a key to competitive differentiation between companies. That is why we need a reference model that reflects the main characteristics of the organization and logistics management of internationally leading companies, so that through a benchmarking process each company can determine the main weaknesses that should be the object of a development strategy with in order to accelerate the evolution of our logistics and it becomes a powerful tool. Likewise, Chen and Bidanda (2019) pointed out that currently logistics management is a distinctive factor of organizations and it is part of the system approach that links the fundamental processes of a logistics system; including supply (purchasing management, storage, inventory management), production, distribution or sales, reuse or reverse logistics.

Loree and Aros-Vera (2018) developed a mathematical model to determine distribution points and inventory distribution locations in humanitarian logistics after a disaster. The model minimizes the cost of site selection, logistics, and facilities

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shortages (i.e., the cost to survivors due to inability to source key materials) and allows multiple distribution points to serve demand nodes. Ji et al. (2018) studied the problem of logistics scheduling in a three-tier supply chain environment comprised of suppliers, manufacturers, and customers. Finally, they showed that inventory cost is related to workflow time, which is the time between when work arrives at the manufacturer and finishes processing and leaves the manufacturer.

In the same way, Hur et al. (2018) studied the inventory control of aircraft spare parts at the end of the life cycle of an airline's fleet operations. They found that as the aircraft approaches the end of its useful life, managing the spare parts supply chain becomes more challenging and expensive. To this end, they designed an algorithm that can meet the spare parts requirements for aircraft components at the end of the aircraft's useful life, and can be used as a useful performance indicator during the management of the aircraft spare parts supply chain in a performance-based logistics environment. Wiecek (2016) presented a proposal to combine fuzzy logic and the genetic algorithm and control the company's purchasing management process. The method proposed by Wiecek and the simulations carried out show that when demand, delivery time and other random factors with great uncertainty affect the supply system, the classical method to determine the inventory level is invalid and ineffective.

For this reason, the importance and justification of the research lies in the fact of presenting a schematic map that ensures compliance and optimizes supply management focused on purchasing, storage and inventory management. For the above reasons, the objective of this research is to use a statistical method to evaluate the impact of purchasing, storage and inventory management on the production costs of a private company, so that management becomes important. In this way, the company will be able to use a tool to develop supply management, and that will serve it in making tactical-operational decisions of the subsystems, thus contributing to the continuous improvement of production management in the organization.

2. Literature Review

2.1 Provisioning of Materials

López (2014) indicates that supply or purchase are two terms with very similar meanings. Procurement refers to the supply or acquisition of necessary things, and purchase also means acquisition of goods, but in commercial terms there are obvious differences between them, and in the logistics process they fulfill specific functions that make them unique. Procurement management is a set of operations that a company performs when it must carry out its manufacturing or marketing activities of products to obtain the necessary materials. It includes the planning and management of purchases, the storage of the necessary products and the application of technology, which allows keeping the inventory of each material to a minimum to ensure that all these operations are carried out in the best conditions and at the lowest cost.

A good provisioning policy can achieve the general objectives of the company through good inventory management under the best conditions of supply and quality. For this, the company must establish lines of coordination between different departments or directions, and define requirements and budgets. The main functions of supply management are: obtaining the materials necessary for the production or commercialization of the product, using technologies that allow maintaining a minimum inventory of each material to manage the storage of the product, and controlling the inventory and costs related to the products. materials (López, 2014).

Likewise, the inventory stored represents the investment in fixed capital, so from an economic point of view it is convenient to balance the level of inventory with the rhythm of sales or the quantity of each product required by the company. An excessive inventory can generate high maintenance costs (space, storage, maintenance and processing costs) and reduce the competitiveness of the company, on the contrary, an insufficient inventory can mean lost sales, customer dissatisfaction or these losses (Vasquez, 2010).

On the other hand, from an efficiency point of view, this is to ensure that the required products or services are provided in a timely manner with the appropriate quality and quantities needed when necessary. From the point of view of efficiency, supplies try to ensure that the cost of the resources used to achieve the previous objectives for various activities is as low as possible (Shifino, 2008), which also indicates that the provisioning function includes three basics: provisioning, storage and inventory management.

2.2 Purchasing Management

Ayala (2016) points out that good procurement management tries to provide the company with all the necessary quantities of materials and services from the ideal supplier with the highest possible quality and at the best price at the right time. In other words, it strives to comply with the standards established by the company for its correct operation, respecting time, quality, quantity and cost. Thanks to good procurement management, a stable and continuous material flow can be maintained according to the needs of the organization, establish a good relationship with suppliers and establish channels that guarantee fluid and two-way information, select new suppliers, develop, evaluate existing ones objectively and increase the rate of inventory turnover, which will lead to adjustments and reductions of the same, maintaining the service to customers.

2.2.1 Stable Flow and continuous of Materials

Good management software can help us determine the requirements or needs for collecting company materials. Whether it is raw materials, spare parts or commodities, maintaining the best levels of inventory in our facilities, ensuring that our production lines are properly supplied or maintaining a high level of service to customers is vital to reach commitment desired level of competitiveness (Martínez, 2007).

2.2.2 Value and Evaluate Suppliers

In order to prepare the best flow of material for the company, we must establish a series of standard evaluation and carry out continuous evaluation of the suppliers. Assuming that the products we buy are technically sufficient to cover the needs of the company, we can establish a series of simple standards that help us determine which supplier or suppliers best suits each of our needs. The first thing to remember is that after the initial evaluation, it is necessary to carry out a continuous evaluation of each standard of each supplier (Martínez, 2007).

2.2.3 Bidirectional Information Flow

The exchange of data in real time between the provider and the company will ensure that the objectives are achieved. There are systems such as the Administrative Management System (AMS) which are widely used in various institutions, and can be configured to inform what is considered to be relevant for the supplier, for example, the maximum level of inventory and security of each reference that a supplier in particular we must provide us to ensure that others belong to others and always keep them at an appropriate level (Ayala, 2016).

2.3 Storage

Pérez (2014) indicates that storage logistics is in charge of managing and planning everything related to the elements, commodities or raw materials that the company receives for its activities. The storage logistics processing tasks include the placement and storage of the received materials, maintaining their correct condition and ensuring that the storage of all these materials has a positive impact on the activities of the company. In other words, they're not just trying to store but they are also trying to improve storage efficiency. So, for example, we do not have to place and store everything perfectly. Another definition is associated with Escudero (2014) who points out that storage is one of the most important logistics services in the company's supply chain, since in addition to storing products in the physical space, it also carries out control, availability and product requirements and product transfer.

All warehouse logistics tasks seek to achieve a series of objectives, such as: maximize space, minimize inventory costs, reduce routes in the picking process, perform all storage operations in the shortest possible time, avoid stock outs or guarantee the supply of products.

2.3.1 Types of Storage

The product can be placed indoors to prevent the product from being affected by any weather, temperature and light, or it can be placed outdoors, where the product is in a place delimited by a fence or other objects. In addition, storage can be done by product type, where raw materials, intermediate products, final products, added materials or chemicals or storage can be stored. On the other hand, storage can be carried out according to the type of logistics function, such as financial storage, which is the custody, custody and protection of the goods protected under the customs tax warehouse system. It allows importing goods, while delaying the payment of taxes and complying with non-tariff regulations, and it can also be stored in transit. Its function is to store products for several hours, since the main purpose is to optimize the transport process and transport occupation (Escudero, 2019).

2.4 Inventory Management

Inventory is the accumulation of materials throughout the production process of the company. They consist of inventory items, usable or in process, such as finished products, parts, sub-assemblies, raw materials, or materials in process or in transit. Depending on the type of company involved, whether it is a manufacturer or a seller, the level of inventories can represent up to 60% of the cost of working capital, which is why proper management of them is the key to a successful execution (Vásquez, 2010). Similarly, Aguilar Santamaría (2013) pointed out that inventory is a very important asset, because it exists mainly to satisfy sales demand, amortizing between two systems: supply (production or supply) and demand (customer or distributor). In this way, it guarantees that the investment in them is minimal at the highest level of service.

2.4.1 Types of Inventory

Render and Heizer (2009) indicated that there is a large number of past studies focused mainly on the total amount of inventories carried out, but not on the impact that different inventories of raw materials, products in process and products could have over time. finished. For this reason, Render and Heizer define and classify the following types of inventory to be applied in any organization to carry out a correct provisioning or supply:

- Inventory of finished products: Includes goods that can already be delivered to customers and meet demand. It can be said that the inventory level directly depends on the demand and sales of the product itself.
- Raw material inventories: it involves the elements considered for the elaboration of other products.
- Inventory and products in process: includes elements submitted in a process for the elaboration of a product that is not yet finished or concluded.

2.4.2 Inventory Policy

Inventory strategy is a procedure by which we can define the required inventory level (how much?) and keep the physical inventory as close and available as possible (when?). When planning inventory, according to the revised definition, we must consider two things: first, it will not have a negative impact on the finances of the company; second, it allows us to provide a sufficient level of customer service (Eroglu & Hofer, 2011).

2.5 Provisioning Objectives

Escudero (2011) pointed out that, to achieve optimal supply management, companies must achieve the following objectives:

- Identify the needs of the organization achieving a necessary and sufficient inventory so that there are no shortages in the production of raw materials and other supplies.
- According to good inventory management, inventory investment is reduced and storage costs can be minimized due to lost or damaged products, obsolete or perishable items, etc.
- To establish an effective information system, the inventory status must be provided to the relevant departments and the report of the monetary value of the inventory must be provided to the accounting area.
- Work with the purchasing department to achieve economic acquisition while maintaining efficient transportation (including merchandise shipping and receiving activities).

Clearly, these goals cannot be achieved at the same time and conflicts or accidents can occur. Therefore, it is necessary to seek a balance that minimizes the costs associated with each of them, while seeking to maximize customer service.

3. Model and Hypothesis

In the research, the dependent variable will be the company's production costs, which in turn is made up of the following indicators:

- Direct production costs: raw material costs are included here.
- Indirect production costs: here are included the expenses related to salaries and costs that do not interfere in the production process

Likewise, the independent variable of the research will be the Provisioning, which is made up of three indicators:

- Purchase management: measured through the number of suppliers hired per month.
- Storage Management: measured through the level of stock and income and exits balance.
- Inventory Management: inventory rotation.

Having the variables and indicators identified, the following research hypotheses were evaluated:

- H_1: Purchase management has a negative and significant impact on the production costs of the Softys company.
- H_2: Storage management generates a positive and significant negative in Softys company's production costs.
- H_3: Inventory management has a negative and significant impact on the production costs of Softys company.
- H_4: The number of suppliers hired per month has a negative impact on the production costs of the Softys company.
- H_5: The stock level has a positive impact on the production costs of the Softys company.
- H_6: Inventory turnover has a positive and significant impact on production costs.

4. Methodology

The present investigation was quantitative, cross-sectional and with a non-experimental design. To achieve the proposed objective, the results are aimed at using a multiple linear regression model and correlation analysis to determine the impact that exists between the variables, as well as their meaning. For this, the estimation method will be that of ordinary least squares, since it is the most common method to carry out an estimation, where the unknown parameters of a stochastic relationship are the objectives of the estimation, by minimizing the sum of the squared errors (Zhen, Qiang & Yincheng, 2019).

$$Min \sum e^2 = \sum_{i=i}^{n} (y_i - b_0^{'} x_i)^2$$

where:

e^2 = is the error squared to have only positive errors.

y_i = is the series of the observed dependent variable.

$b_0^{'}$ = is the parameter or estimator of the regression.

x_i = is the series of the observed independent variable.

n = is the total number of observations in the series.

i = is each observation of each series.

The formula shown simplifies the main objective of the OLS technique, which is to minimize the sum of the squared errors to obtain unbiased and consistent estimates, with the aim of reducing the difference between the observed dependent variable and the estimated variable.

4.1 Sample

The data belongs to the company Softys, which is distributed in a weekly period from January 2018 to December 2019, which gives 48 observations for each study variable, a fact that allows stability and consistency in data, and to get closer to the reality. The variables and indicators are summarized in the following table together with the abbreviation used in the model.

Table 1
Variables, dimensions and indicators

Variable	Dimension	Indicator
Production costs (PC)	Direct production costs Indirect production costs	Raw material expenses (RME) Remuneration expenses, maintenance and general (RE)
Purchasing Management (PM)	Providers	Number of local Suppliers (SUPP_LOC) Number of foreign suppliers (SUPP_FOR)
Storage Management (SM)	Level of merchandise in warehouse (LMW)	Stock (STOCK) Balance (BAL)
Inventory Management (IM)	Inventories (INV)	Inventory Rotation (INV_ROT) Merchandise Value (MV)

Source: Own elaboration.

5. Results

5.1 Descriptive statistics

According to the statistical data shown in Table 2, it can be seen that the most stable variables are spending on purchases, given that their standard deviation is not so far from their environment, the same analysis can be intuited from inventory management, storage costs, raw material costs, local and foreign suppliers, stock level and balance. While the variables that present much dispersion of their observations around the mean are general expenses, inventory turnover, and the value of merchandise.

Table 1
Descriptive statistics

	Obs	Half	Standard Deviation	Rank
PC	48	222585.1	16432.94	64175
PM	48	54.95833	7.007468	24
SM	48	15973	2933.419	9602
IM	48	815362.1	119116.3	412088
RME	48	94303.83	8695.758	28611
RE	48	128281.3	15251.13	48832
SUPP_LOC	48	15.25	3.152169	10
SUPP_FOR	48	39.70833	6.347921	20
STOCK	48	15240.94	2926.166	9597
BAL	48	732.0625	133.6583	465
INV_ROT	48	236206.5	26319.9	69536
MV	48	579155.6	111194.3	364486

Source: Own elaboration.

5.2 Statistic analysis

Table 3 shows the correlations between all the variables of the research, as it can be seen, there is a positive linear relationship between certain variables and a negative one in others, but the interpretation of certain correlations may be spurious due to the fact such association between variables does not exist, therefore, only the variables raised in the hypotheses will be analyzed. As had been raised in the research hypotheses, purchasing management has a negative relationship of -0.17 with production costs, storage management has a negative relationship of -0.35 and inventory management has a negative relationship of -0.35, which makes theoretical and practical sense, since as management improves, optimizes or increases, production costs should decrease due to the fact that economies of scale are taken advantage of by producing more, having more suppliers or investing in more staff to optimize the company's sales. On the other hand, as the company hires more personnel or hires more suppliers, whether local or foreign, production costs decrease. However, the relationship with the stock and inventory level is negative when it was expected to be positive.

Table 2
Correlations Matrix

	PC	PM	SM	IM	RME	RE	SL	SF	STK	BAL	INV	MV
PC	1											
PM	-.17	1										
SM	-.35	.01	1									
IM	-.35	.04	.97	1								
RME	.39	-.10	-.36	-.31	1							
RE	.85	-.13	-.17	-.20	-.14	1						
SL	-.13	.42	.03	.06	.09	-.20	1					
SF	-.12	.89	-.00	.01	-.16	-.04	-.02	1				
STK	-.37	.01	.99	.97	-.36	-.19	.04	-.00	1			
BAL	.26	-.04	.07	-.00	-.05	.31	-.13	.01	.03	1		
INV	-.03	.11	.18	.40	.10	-.09	.10	.07	.19	-.14	1	
MV	-.37	.01	.99	.97	-.36	-.19	.04	-.00	.99	.03	.19	1

Source: Own elaboration.

5.3 Modeling

In accordance with the data previously analyzed, and in accordance with the objectives set, the regression models will be carried out where the impact between the variables and their significance will be determined.

Table 3
Model Specification by OLS

Method: Ordinary Least Squares Dependent variable: Production Costs (PC)							
Model 1		Model 2		Model 3		Model 4	
Variable	Coefficient / Stand. Dev.	Variable	Coefficient / Stand. Dev	Variable	Coefficient / Stand. Dev	Variable	Coefficient / Stand. Dev
PM	-411.61 / 340.39	SM	-2.008** / 0.7710	IM	-0.049** / 0.0190	PM	-396.48 / 326.81
C	245206.8*	C	254665.3*	C	262542*	SM	-1.82 / 3.41
						IM	-0.04 / 0.084
						C	27709***
R^2	0.03	R^2	0.12	R^2	0.12	R^2	0.15
Normalcy	0.45	Normalcy	0.1441	Normalcy	0.1442	Normalcy	0.09
RMSE	16353	RMSE	15506	RMSE	15527	RMSE	15590

Note: ***Significant at 1%, **Significant at 5%, *Significant at 10%
Source: Own elaboration.

We perform a second modeling for hypotheses four, five and six, and thereby decide whether or not there is a significant impact between the variables.

Table 4
Model Specification by OLS

Method: Ordinary Least Squares Dependent variable: Production Costs (PC)					
Model 5		Model 6		Model 7	
Variable	Coefficient / Stand. Dev	Variable	Coefficient / Stand. Dev	Variable	Coefficient / Stand. Dev
SUPP_LOC	-729.67 / 763.5	STOCK	-2.085*** / 0.768	INV_ROT	-0.024 / 0.091
SUPP_FOR	-336.58 / 379.1	C	254375*** / 11926	C	228263***
C	247078*** / 19436				
R^2	0.03	R^2	0.138	R^2	0.0015
Normalcy	0.4763	Normalcy	0.1271	Normalcy	0.5325
RMSE	16494	RMSE	15422	RMSE	16598

Note: *** Significant at 1%, ** Significant at 5%, * Significant at 10%
Source: Own elaboration.

6. Discussion and Conclusions

According to the results found in Table 4 and Table 5, the first hypothesis of the research could be contrasted, where indeed the purchasing, administrative and inventory management have an impact on production costs, and this impact is negative.

That is, interpreting the results of model 1 in Table 4, as purchasing management is improved by one unit, production costs are reduced by 411.61 with a standard deviation of 340.39, however, this result is not significant, and the fit of the model is 0.03, which is very low, however, the errors of the model are normal with a value of 0.45 being greater than 0.05, therefore, the result is valid. On the other hand, in model 2 of Table 4, the increase in one unit of storage management reduces production costs by 2.008 with a standard deviation of 0.77, and this value is significant and presents an adjustment of 0.12, greater than model 1, with normality in errors of 0.14 greater than 0.05, corroborating and accepting the second hypothesis of the investigation. In model 3 of Table 4, it can be observed that inventory management, and as in the previous analysis, the production cost is reduced by 0.049, the result being significant, with a standard deviation of 0.01, and the adjustment of the model is also 0.12, presenting in turn normality in the errors like model 3, presenting a value of 0.14 greater than 0.05, and thus corroborating the fourth hypothesis of the investigation. The last model in Table 4 is a multivariate model, since we consider the purchase, storage and inventory management, the sign of the three models is maintained, and even the adjustment of the model also increases to 0.15, the errors remain normal. However, the square root of the error is slightly higher than that of the other models, nevertheless, the results still represent good model.

In Table 5, we can observe the results of model 5 and thus contrast hypothesis four of the investigation, since the number of the company's supplier, according to the model, negatively impacts production costs at a value of -729.67 for local suppliers and -336.58 for foreign suppliers, both with a standard deviation of 763.5 and 379.1 respectively, that is, as there are more suppliers, production costs will be lower, which presents normality in errors with a value of 0.47 but with a low model fit. What can be interpreted from these results is that the company diversifies its costs by having more and more suppliers or by changing them in order to find better prices in the market, and in this way its production costs decrease. In model 6 presented in Table 5, it can be observed that the stock level also has a negative relationship with the cost of production, by giving a parameter value of -2.08 with a standard deviation of 0.76 with a greater adjustment than others. This can be interpreted as a measure to appease the amount of purchases, since, if there is a greater quantity of stock in the warehouses, the company could stop producing a little more in the following period, in order not to incur expenses that cause an increasing level of stock, thus corroborating the fifth hypothesis of the investigation.

In model 7, it can be noted that inventory turnover also reduces production costs, by giving a parameter value of -0.024 with a standard deviation of 0.091, however, the fit of the model is very low, becoming only 0.0015, thus corroborating the sixth hypothesis of the investigation.

Relating the results proposed and found based on the analysis, recently, Geissdoerfer et al. (2017) suggested that the industry and policy makers should promote the concept of “circular economy”, which requires the use of cyclical and non-linear systems to make better use of resources, which goes in the direction of what was found. As the company produces more, it will be able to sell more and thereby reduce its production costs, thus producing a cyclical system of effectiveness. They also explained the similarities and differences between the circular economy and (environmental) sustainability, which will help not only optimize supply management in companies, but also position it as a socially responsible company, a very particular characteristic that current consumers tend to value in companies. On the other hand, it is important to mention that industrial policies can help create an environment that allows manufacturing companies to be competitive in high-cost economies. The central theme is innovation: manufacturing depends on it to create value, and industrial policies must increasingly include innovation policies. From the perspective of the innovation system, the role of industrial policy is to overcome the failures of the system, promote interaction and cooperation between the company and other agents of the system, and encourage innovative behaviors (Spring et al., 2017). However, it is an issue that needs further development in private companies, which is truncated mainly due to the monetary and time cost involved in carrying out these operations, considering the budgetary and capital limitations. Finally, with the results presented, the final conclusion of the research is that the results achieved will allow us to know the variables that have a greater impact on the reduction of production costs; and thus, make subsequent decisions based on these forecasts in a correct and timely manner.

In summary, the proposed model has evaluated the impact of materials supply management was inversely proportional, that is, as purchasing, storage, and inventory management in companies improve, their production costs are reduced.

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