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Methodology for relating the cost of employee turnover, employee retention, and lost production costs.

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I. OBJECTIVE

Employee turnover is a global phenomenon that can significantly impact productivity and profitability. The costs associated with employee turnover, such as training, lost production, and decreased morale, can be considerable. In the global context, the turnover rate has remained relatively stable in recent years at around 10.9% [1].

Some measures help increase employee loyalty to the organization, defined by [2] as the feeling of belonging and commitment to the company. This helps reduce turnover, i.e., the constant flow of people in and out of the organization.

Employee turnover can be voluntary, when the employee leaves the company, or involuntary, when the company dismisses the employee. Others [3] classify voluntary turnover into two types:

Turnover due to dissatisfaction occurs when the employee is unsatisfied with his job, company, or personal life.

Opportunity turnover: Occurs when the employee finds a better employment opportunity in another company.

Involuntary turnover can be caused by factors such as downsizing, employee underperformance, or retirement.

Increased turnover involves increased costs to the firm, such as the costs of recruiting, selecting, and training new employees, as well as severance and settlement costs for employees who leave the firm. Many authors [2], [4], [5] estimate that turnover costs can be significant.

When organizations must cut costs or downsize to adapt to market contraction, they offer voluntary resignation programs [6]. Although there is a widespread conception that workers leave their jobs because of a problematic situation, it is assumed that they leave because they do not like something, feel bad about it, or because it does not make sense to stay in the job [7].

Staff turnover can harm the organization's efficiency, which may indicate the company is losing trained human capital. However, a zero turnover rate can also be harmful since it suggests that the company is not renewing its personnel, leading to the company not innovating in new technological tools that appear in the sector to which it belongs.

In general, it is advisable to have a certain personnel turnover, but this turnover must be controlled so that it is not excessive. Excessive turnover can be a disruptive factor that hinders organizational effectiveness.

Therefore, when turnover is excessive or involves valuable workers, it is a disruptive factor that hinders organizational efficiency.

In conclusion, employee turnover is a complex phenomenon that can affect the company positively or negatively. Companies must understand the factors that cause turnover and take measures to control it.

The dilemma arises when personnel turnover is voluntary but in critical positions where replacement is difficult and complex.

The question then becomes how much the company loses by not being able to retain these committed and involved personnel who are looking for new economic opportunities, which they can access because they are well-trained.

On the other hand, we have the internal issue of the cost of dismissal and its close relationship with the cost of training, which, according to [8], is an unrecoverable cost.

II. STATE-OF-THE-ART

This proposal is intended to be framed within some commonly used concepts such as:

1. *Standard Time (ST) is "The time required to produce an item at a manufacturing station, with the following three conditions: 1. skilled and well-trained operator; 2. manufacturing at normal rate; and 3. doing a specific task." [7]*
2. *Efficiency (Ef) is the ratio of actual production to standard production [13].*
3. *Standard output: This is developed by dividing the base time by standard time [13].*

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4. *Base time refers to a worker's working day (e.g., 48 hours/week or 8 hours/shift).*
5. *Fixed indirect manufacturing costs, are those that do not vary with the production volume [9]. [10].*
6. *Fixed administrative expenses, in this case, 100% of administrative expenses are fixed.*
7. *Fixed sales expenses do not vary with sales volume. [10].*
8. *Net profit is the difference between total revenues minus production costs, administrative expenses, selling expenses, and taxes.*
9. *The production budget is the estimated amount of direct materials, direct labor, and indirect manufacturing costs that occur in a given period [10].*
10. *Economic impact is the loss or loss of income due to an uncorrected cause of a problem.*
11. *The learning curve is a line that shows the relationship between the production time of a unit and the cumulative number of units produced, and the cumulative number of units produced [13].*

The following formula gives the learning curve formula [14]:

$$Tn = T1 \times n^{(\frac{Logb}{Log2})} \ldots(1)$$

Where:

Tn = Time needed to perform the task at time n.

$T1$ = The time required to complete the task on the first attempt.

n = Number of attempts.

b = It is the constant of learning.

We will now analyze some authors who have written on this subject and start with the dilemma when personnel turnover occurs voluntarily but in crucial positions where replacement is difficult and complex.

Then the question would be how much the company loses by not being able to retain this committed and involved personnel, but who are looking for new economic opportunities, to which they have access because they are well trained.

The vast majority of studies found mainly cite as necessary the calculation of dismissal as a purely external approach to the firm, as stated by Di Tella, Rafael, and MacCulloch, Robert: Employment protection policy, which governs the magnitude and composition of dismissal costs, has notable economic and redistributive consequences. Some gain and some lose; some firms and categories of workers benefit more than others (e.g., manufacturing or services, stable or precarious workers, young or old, men or women, skilled or unskilled workers, etc.). Protective employment legislation is often associated with values of justice, but its social consequences are rarely examined on the ground; it has usually been claimed to have counterproductive effects [11].

III. METHODOLOGY

First, the related concept of training cost is analyzed, where some formulas related to the cost of training and the relationship with efficiency and the worker's salary have been described, ensuring that this is only achieved by defining the costs: "This procedure will allow us to have a technical basis for calculating the cost of training or training included in the cost of dismissal of the direct operating worker that does not start from the external costs that are determined at the end of the employment relationship" [12].

Based on the approach parameters such as efficiency, worker's salary, and time are feasible to take to a graph and be able to make the following analysis:

I. Production stopped due to a lack of personnel.

To develop this point of view, it is assumed that the personnel that worked in the company and before leaving it complied with some premises:

a) The worker who held the position before the entry of the new worker developed an A1 area production; he was an average qualified worker.

b) The working conditions were optimal.

c) It was an operation, task or activity that was defined

d) The increase in efficiency is constant with a positive slope.

e) No scrap, rework, or other waste or muda is evaluated.

f) The time that elapses for the Human Resources (HR) area to fill that job is Tx.

g) After hiring this new worker, they started with a production from zero until achieving a production volume such that they are reimbursed the salary that the company gives them. This means efficiently fulfilling the learning curve.

h) The standard time is a time to reach, which when applied in A2, establishes the learning curve which will be based on the training time of the new worker until reaching the efficiency required by the company

The following figure shows the loss of production in areas A1 and A2. Where A1 is the lost production after the worker breaks the labor link, that is, from To to Tx; which is the point in time where the replacement is obtained, from there the replacement will enter an induction and training program until reaching the efficiency requested by the company for that operation. All this occurs from the time Tx to Ty, where the area A2 is born, which would be the area that represents the production that the new worker does not perform until it reaches the efficiency required by the company.

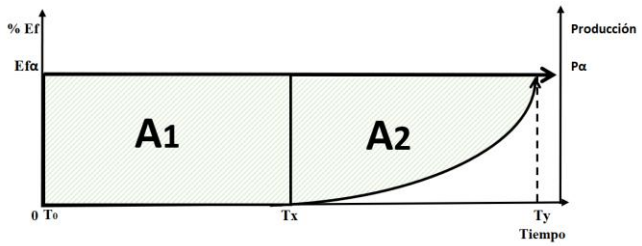

Fig. 1 Loss of production during the time the replacement personnel is not hired, and the production not performed by the replacement during the learning curve.

Note: Own elaboration

Where:

%Ef = Efficiency percentage
Efα= Is the minimum efficiency level requested by the company.
T0 = Starting time when the worker is no longer at his job.
Tx = Is the time when the new worker starts replacing the previous one.
Ty = Is the time when the worker reaches adequate efficiency to justify his salary.
(Ty - Tx) = Is the time it takes for the worker to reach an adequate level of efficiency.
Pα = It is the real production at an efficiency level Efα.

The shallow area represents the production that is not performed due to not having the worker in his job, and until HR gets the replacement, this goes from T0 to Tx, and the other shallow area goes from Tx to Ty. Where Tx represents the entry of the new worker in the job, and Ty describes the moment when the worker reaches the appropriate level of efficiency according to the income received.

The following formulas can be derived from this graph, which are as follows:

$$Ef = \frac{PR}{PE} \ldots (2)$$

Where:

PR = Actual production foregone by the average skilled worker during base time.
PE = Standard production

It is also known that:

$$PE = \frac{Tb}{TE} \ldots (3)$$

Where:

Tb = Base time or working time according to contract or time spent at the work center.
TE = Standard time per unit of product processed

If equation 2 is replaced in equation 1, we have:

$$Ef = \frac{PR}{Tb}\ x\ TE \ldots (4)$$

This will result in that for the range from $T_0 = 0$ to Tx, the Pα, i.e. A1, will be:

$$A1 = \int_0^{Tx} \int_{\propto=0}^{Ef} \left(\frac{Ef\alpha \times (Tx - T_0)}{TE}\right) \ldots (5)$$

From formula (1), the following can be inferred, for the range of (Ty - Tx), i.e., for A2, it represents the Tb which establishes that the PR reached by the worker who recently entered that job will be equal to:

$$A2 = \int_{Tx}^{Ty} \int_0^{\propto} \left(\frac{Ef\alpha\ \times\ (Ty - Tx)}{TE}\right) - \int_{Tx}^{Ty} \int_0^{\propto} \left(\frac{Ef\alpha\ \times\ (Ty - Tx)}{TE}\right)^{p\alpha} \ldots (6)$$

Where:
pα = Exponent representing the slope of the learning curve. This always pα is more significant than one

Here, a double integral will be used since the behavior of efficiency Ef and time T are independent.
As can be seen, the sum of equations (4) and (5) allows us to determine the volume of production lost when the company delays and hires a replacement worker in the position of the worker who left the company. Then the Lost Production (LP) which is the sum of (A1 + A2) will be equal to:

$$PP = \int_o^{Tx} \int_o^{\propto} \left(\frac{Ef\propto \times (Tx - T_0)}{TE}\right) + \left(\int_{Tx}^{Ty} \int_0^{\propto} \left(\frac{Ef\alpha \times (Ty - Tx)}{TE}\right) - \int_{i\,=\,Tx}^{Ty} \int_0^{\propto} \left(\frac{Ef\alpha \times (Ty - Tx)}{TE}\right)^{p\alpha}\right) \ldots (7)$$

This equation is used to determine the unrealized production from the time the old worker leaves until the new worker reaches the efficiency levels required by the company.

II. ***Additional production due to the retention of personnel through salary increases***

One of the mechanisms that the company has apart from the best working conditions is increasing the worker's income so that he does not leave his job. That is why the cost of labor

and the repercussions on the production costs will be an important factor that allows us to see the positive impact of retaining personnel.

For this purpose, the following figure is developed, where the premises are as follows:

a) The worker is an average qualified worker
b) The working conditions are standard
c) The activity, operation, or task has an established procedure.
d) The increase in efficiency is constant with a positive slope.
e) No waste, reprocessing, or any other waste or muda is evaluated.
f) Increasing income generates an increase in production and efficiency.

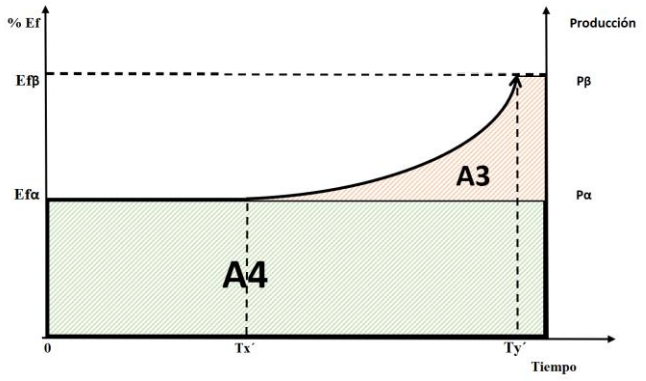

Fig. 2 Production realized by the worker with an increase in his income at the same time if a new worker had replaced him.
Note: Own elaboration.

Where:

Efα = Efficiency of the worker who had been working in the job.
Efβ = worker efficiency with increased income (it can be an incentive or a direct increase in productivity).
T_0 = Time since he/she maintained the efficiency level adequate for the company, by the salary received.
Tx' = Time when the increase in income is offered.
Ty' = Moment where the worker establishes the maximum efficiency level about the increase or incentive achieved.
Pα = Production carried out at a regular rate with an efficiency commensurate with the perceived increase in income.
Pβ = Maximum production reached after improving his income.

A4 is defined as the production that the worker delivers since he remained in his job, and A3 is the increase in output due to an improvement in his income.

$$PSR = A3 + A4 \ldots (8)$$

Where:
PSR = Production Without Staff Turnover

If we consider equation (3), it is obtained from Figure 2 that A1 is influenced by the efficiency Ef and time, thereby obtaining that for the range of $T_0 = 0$ to Ty', it will be

$$A3 = \int_{Tx'}^{Ty'} \int_{Ef\alpha}^{Ef\beta} \left(\frac{(Ef\beta - Ef\alpha) \times (Ty' - Tx')}{TE} \right)^{p\beta} \ldots (9)$$

Where:
A3 = Real production the worker achieves by improving his income through incentives.
pβ = Exponent representing the slope of the learning curve. This always pβ is more significant than one.

Or the range of (Ty' - T0), where the production achieved by the worker at an efficiency accepted by the company is established.

$$A4 = \int_{T0}^{Ty'} \int_{Ef0}^{Ef\alpha} \frac{(Ef\alpha - Ef0) \times (Ty' - T0)}{TE} \ldots (10)$$

Here, a double integral will be used since the efficiency Ef and time T behavior are independent.
As can be seen, the sum of equations (9) and (10) allows us to determine the volume of production that will be produced when the worker remains at the workstation. Then the PSR, which is the sum of (A3 + A4), will be equal

$$PSR = \int_{Tx'}^{Ty'} \int_{j=Ef\alpha}^{Ef\beta} \left(\frac{(Ef\beta - Ef\alpha) \times (Ty' - Tx')}{TE} \right)^{p\beta} + \int_{T0}^{Ty'} \int_{Ef0}^{Ef\alpha} \frac{(Ef\alpha - Ef0) \times (Ty' - T0)}{TE} \ldots (11)$$

This equation will determine the PSR where the worker was retained and motivated to increase production.

III. ***They lost production costs due to the change in personnel and the marginal cost of production due to the increase in the worker's income.***

Another assumption that we will define is that we have established a minimum level of production as a company, and this is related to the company's fixed costs.
The relationship of fixed costs of any company is given in the following way which we are going to enumerate:

i. Fixed indirect manufacturing costs
ii. Fixed administrative expenses
iii. Fixed selling expenses

iv. Financial expenses (for long-term debt)

If we look at the effect on production, we will say that it is equal to:

$$CIFFUP = \sum \frac{CIFF}{UPP} \dots (12)$$

Where:

CIFFUP = Fixed indirect manufacturing cost per budgeted units
CIFF = Fixed indirect manufacturing costs
UPP = Budgeted production units

If it is required to know how much the cost of the units that were not manufactured because of personnel turnover and the delay in replacing those personnel by HR, it will be equal to the multiplication of formulas (6) and (11):

$$CPRPU = PP \times \text{CIFFUP} \dots (13)$$

Where:

CPRPU = Cost of loss due to unit personnel turnover

If you have motivated and economically incentivized personnel, the fixed costs of increasing production volume will be diluted over a higher volume, then your formula will be:

$$CMSRP = \sum \frac{CIFF}{(UPP + UIP)} \dots (14)$$

Where:

CMSRP = Marginal Fixed Indirect Manufacturing Costs without personnel turnover.
UPP = Budgeted units produced.
UIP = Incremental units produced.

Then the calculation of the unit CIF for an additional production volume would be given by the difference of the budgeted unit indirect manufacturing costs CIFFUP minus the marginal unit fixed indirect manufacturing costs without personnel turnover CMSRP:

$$V = (CIFFUP - CMSRP) \dots (15)$$

Where:

V = Additional indirect manufacturing cost per unit.

Thus, we would have a marginal income of:

$$IM = V \times PSR \dots (16)$$

Where:

IM = Marginal income

If a company were to achieve these two scenarios at the same time, we would be facing a total economic impact by having a staff turnover and not being able to motivate the staff:

$$PT = IM + CPRPU \dots (17)$$

Example:

In a company, a worker decides to resign for a salary improvement in another company, and the work he performs has a standard time of 1 minute/product, with an efficiency of 85%, the unit fixed indirect manufacturing cost of the product is S/.0.5 per unit.

Now let's assume that HR takes a month to find a replacement and once it is found, it takes another month to reach the same efficiency as the initial worker (85%), the production loss can be estimated by making the following calculation:

First employee data:

TE = 1 minute/unit
Efficiency = 85%.
CIFF = S/.0.5 per unit

Solution:
The loss originating from the first worker will be applying the formula (4):

Lost production in a month = 0.85 x 26 days/month x 480 minutes/day x S/.0.5 /unit
1 minute/unit

Lost production in the month when the replacement is not obtained = S/. 5304/month.

Second employee data:

In one month (26 days), it reaches an efficiency of 85%.
Solution:
The loss originated by the second worker will depend on the linearity of the efficiency, i.e., it is assumed that the efficiency growth is constant and linear and an average efficiency of 42.5% during the month is set (for ease of calculation)

Where we apply the formula (5)

Lost production in a month = 0.425 x 26 days/month x 480 minutes/day x S/.0.5/unit

1 minute/unit

Lost production in a month = S/. 2652/month

In other words, if HR takes one month to find a worker to replace another worker who had been performing with an efficiency of 85%, from the time the worker left his position until the next worker was hired. He achieved the same efficiency one month later, and the total loss for the company was S/. 5304 plus S/. 2652, which gives a total of S/. 7956, without taking into account the case where the demand is unsatisfied and leads to an even more significant loss due to the net profit that the company loses.

IV. EXPECTED RESULTS

This procedure allows, first, to determine the production levels lost due to the voluntary departure of personnel.

Once both production volumes are obtained, we quantify the effect of fixed indirect manufacturing costs on lost production, which is one of the objectives of this work.

The other objective is to have an algorithm that allows us to measure the production volume of the worker who stays to work with an increase in his remuneration, considering that the more qualified the labor force is, the greater the effect on lost production.

It was also determined the volume of production that could be achieved with the personnel who choose to stay and are motivated by an increase in their income to raise the production volume.

This article opens a line of research where the human resources and production department and the cost of the management of hiring and firing personnel are related.

It also establishes guidelines for determining the break-even point between the ideal turnover percentage that can be obtained by each company and industrial sector.

REFERENCIAS

[1] https://www.esan.edu.pe/conexion-esan/rotacion-laboral-en-el-peru-que-hacer-para-disminuirla. Revista Conexión ESAN. Universidad ESAN. 2019

[2] I. Chiavenato, "Comportamiento Organizacional. La dinámica del éxito en las organizaciones". México: McGraw Hill. 2009.

[3] C.P. Tamayo. "Modelos Teóricos e Investigación sobre Rotación de Personal", México, (2008) pp 54

[4] W. F. Cascio, "Costing Human Resources" (3ª ed.) 1991. New York: McGraw-Hill, p. 52

[5] L. Gomez-Mejia, D. Balkin, Cardy I. "Gestión de los Recursos Humanos". Madrid.2008. Pearson Prentice Hall. pp. 228-230

[6] D. S. Hamermesh and G. A. Pfann, "Adjustment Costs in Factor Demand," J. Econ. Lit., vol. 34, no. 3, pp. 1264–1292, Sep. 1996, [Online]. Available: http://www.jstor.org/stable/2729502.

[7] S.P. Robbins "Comportamiento organizacional". Pearson Educación de México, S.A. de C.V. Décima edición. Naucalpan de Juárez, Edo. de México. pp 24-27 pp 81. 2006. ISBN: 970-26-0423-0.

[8] B. P. FREYENS, "Costos del despido y ventajas de la medición con métodos directos," Rev. Int. del Trab., vol. 129, no. 3, pp. 317–348, 2010, doi: 10.1111/j.1564-9148.2010.00088.x.

[9] C. Horgren, S. Datar, M. Rajan. "Contabilidad de costos – Un enfoque gerencial". Decimocuarta edición, Pearson Educación de México, S.A. de C.V. México. pp. 37. 2012. ISBN: 978-607-32-1024-9.

[10] R. Polimeni, F. Fabozzi, A. Adelberg. "Contabilidad de costos: Conceptos aplicaciones para la toma de decisiones gerenciales". Mc Graw Hill/ Interamericana S.A. Tercera edición. Santa Fe de Bogotá, Colombia, pp. 29. 1997. ISBN: 978-958-600-195-3.

[11] Di Tella, Rafael, y MacCulloch, Robert. 2005. «The consequences of labor market flexibility: Panel evidence based on survey data», *European Economic Review*, vol. 49, núm. 5, pp. 1225-1259

[12] M. Salas-Hidalgo, "An algorithm to determine the cost of training a direct operator". 19th LACCEI International Multi-Conference for Engineering, Education, and Technology. Buenos Aires -Argentina, 2021.

[13] R. Chase, F. Jacobs, N. Aquilano.2006. "Administración de operaciones: Producción y cadena de suministros". Duodécima edición. DF México, México, pp 143 y 168.

[14] B. Niebel y A. Freivalds.2009." Ingeniería industrial. Métodos, estándares y diseño del trabajo". Duodécima edición. DF México, México pp 527-528.