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ASSIGNMENT OF PERSONNEL WITH SHIFTS DEPENDENT OF THE OPERATOR TYPE

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Abstract

This article describes the principal characteristics of a support model to decision-making designed with the purpose of supporting the process of assignment of resources (personnel) in a process of textile production. The tool feeds a linear programming model, which includes factors that contribute to the individual assignment and roles within the process. The device is developed in LP Solve, which offers a manageable interface capable of relating these factors whether as objectives or restrictions, and of adjusting the parameters of the model. The result is an alternative to responding to the group of current competitive exigencies, which is a relevant fact because the resources and the capabilities of the companies are today the main source of competitive advantage, and this option can be a faster, as well as a more precise and economic way to access it.

Key Words: Human resources, mathematic model, LP Solve.

Introduction

The importance in finding efficient methods for the assignment of human resources lies in the fact that in many corporations this is the primal productive factor, considering that the efficiency of such corporations depends, on a high degree, on the well execution of these resources. As such, the management offices are required to take special notice of the process of assignment of personnel, and consider the multiple factors that become more complex in medium and great-sized corporations. This is due to the great amount of possible assignment combinations according to the roles, hours, and men-machinery available.

A lot has been discussed about the strategy, and experience shows that such should contemplate the internal and external elements of the company in response to the management problems of corporations. However, in the last decades these strategies have been oriented towards the market factors, being Porter (1990) the most accepted. This theory aims to the creation of the value of the corporation based on its position in the environment, and establishes strategies of differentiation, costs, and products. Nevertheless, a small part is dedicated to the intrinsic study of the corporation.

Internally, leadership issues, assignment of personnel, and the differences between the members of the team are distinguished as three of the core elements linked to the human factor which affect the success of the corporate strategy of Ryan, (2007). According to this context, an insufficient management of human resources that would allow anticipate and prevent the movement of people within the organization becomes clear.

However, despite the importance of the human factor (RH) in the success of the proper tasks in any corporation, the choice and assignment of personnel is an empiric matter that is limited to the employment without a specific method that would allow calculating whether the process of management of personnel is either correct or erroneous.

Therefore, the management offices require granting special attention to the process of assignment of personnel, and considering the multiple factors that become more complex in medium-sized and large enterprises. This is due to the great amount of combinations possible to this assignment according to the roles, hours and operators available. This makes the process of assignment impossible to address efficiently without the aid of an automatic system that provides support to decision-making based on integral models that illustrate the problem to solve in the most objective way possible.

The ability of a company to generate utilities is based on the attractiveness of the industry, and in the competitive advantages that such corporation possess. However, works which shape this process of personnel assignment are scarce in literature, given that the major part of project administrative tools are centered in optimizing time, resulting in the management of human resources and the prevention of risks in the less attended areas.

Thus, the objective of the present work is developing an integral model of linear programming for the assignment of personnel with support from the tool of decision-making (LP Solve), which manages to include factors that contribute to the individual assignment as well as the roles within the process of production.

The research has significance within the management of a textile complex, for it allows to establish strategies necessary to the optimal use of the resources generated through the process of production, without limiting the use of this device to the area, for the reason that it can be adopted in other management offices that present the same need.

Reference Framework

Theory of Decision-Making

The performance of the organization is dynamic and volatile. Consequently, interactions of performance (internal and external) must be quantified (Najmi et al., 2005), for this calculations allows the parties involved in decision-making to apply corrective measures when necessary. The theory of decision-making is in charge of determining the way a person chooses that measure which, within a group of possible measures, leads him or her to a better result given his or her preferences. The formal approach that the theory assumes is that such preferences, whatever they are, must satisfy certain basic criteria of logical consistency. Among the ones that should be pointed out are the following:

Transitive relation: To all *x*, *j*, *y*, *z*, if *j* is strictly preferred over *y*, and *y* is strictly preferred over z, x will be preferred over *z*.

Connectivity: To all *x* and to all *y*, either *x* is preferred over *y*, and *y* is preferred over *x*, or the individual remains indifferent to them.

Asymmetry: Provided that *x* is preferred over *y*, *y* is not strictly preferred over *x*.

Symmetry of the indifference: To all *x* and *y*, if *x* remains indifferent to *y*, *y* remains indifferent to *x*.

If this requirements are infringed it would turn impossible to know what is that the person prefers; their preferences will not be able to be arranged hierarchically, and the theory of decision-making will conclude that said person does not choose rationally, that is, in a consistent logical way. (Bell, Raiffa y Tversky, 1988: 18; 289, Mari—Klose, 2000). If these requirements are fulfilled it can be attributed to a purpose of utility, that is to say, an index, to each one of their preferences in a way that will be possible to choose the best alternative, and the most appropriate method.

The theory of decision-making operates when the environment and the behavior of the involved parties in the process can be considered as reference, their procedure is foreseeable, and the decisions of the elements are constant in the context of study. Frequently, this type of decisions are part of a pre-established process, and it is assumed that all its executioners are regulated by the same rules.

This work embraces the theory of decision-making with certainty for data of the procedures is supplied.

Linear Programming

Linear programming is a procedure or mathematic algorithm by means of which a particular problem is solved, formulated through linear equations, and this way optimizing the objective function, linear as well, which consists in optimizing (minimizing or maximizing) a linear function. This one is denominated objective function, in a way that the variables of said function are subjected to a series of restrictions that we show through a system of linear equations.

The variables are real numbers larger or equal than zero.

$$X_i >= 0$$

In the case that the resulting value of the variables were required to be a whole number, the procedure of solution is called Linear Programming.

Restrictions

Restrictions may appear in the following way:

Type 1

$$A_j = \sum_{i=1}^{N} a_{i,j} \times X_i$$

Type 2

$$B_j \leq \sum_{i=1}^{N} b_{i,j} \times X_i$$

Type 3

$$C_j \geq \sum_{i=1}^{N} c_{i,j} \times X_i$$

Where:

- A = known value to be strictly respected;
- B = known value that must be respected, or that can be surpassed;
- C = known value that must not be surpassed;
- j = number of the equation, variable from 1 to M (total number of restrictions);
- a; b; y, c = technical known coefficients;
- X = unknown quantities, from 1 to N;
- i = number of the unknown quantity, variable from 1 to N.

Procedure

The methodology used in the present study is descriptive, considering that, and according to Hernández, Fernández, and Baptista, (2010), it calculates and evaluates different aspects, dimensions and components of the subjects to study. It based on the field research carrying out an interpretative analysis of strategies in order to improve the use of human resources. Arias (2000) defines it as “The collection of data directly from reality, without controlling or manipulating the variables”. In general terms, for the development of this work, and based on the previously mentioned data, the following stages were carried out:

1. Making a description of the environment of decision-making. It was followed by the study and characterization of the industrial complex with emphasis in the field of study (Spinning plant) in order to tie congruently the problem of research with relation to the strategies to optimize the human resources through the process of production. (See Figure 2)
2. Researching of the assignment method, and the variables taken into account.
3. Supplying evidence of the tasks given, the time employed in their fulfillment, the personnel in demand, and other aspects that define the tasks to accomplish.
4. Following an inquiry process to the people in charge of carrying out the assignment presently in order to specify factors that would make of the model a more useful tool.
5. Based on points 2, 3, 4, laying out the model that would allow the understanding of all the information needed for the management of the data, intending to obtain the more realistic possible solutions.
6. Adapting the model according to the environment of decision-making of the company bearing in mind the specific requirements in the area, and the factors that would make it accurate.
7. Carrying out tests and evaluations of the results.
8. Employing linear programming and the LP Solve tool with the purpose of developing the implementation.

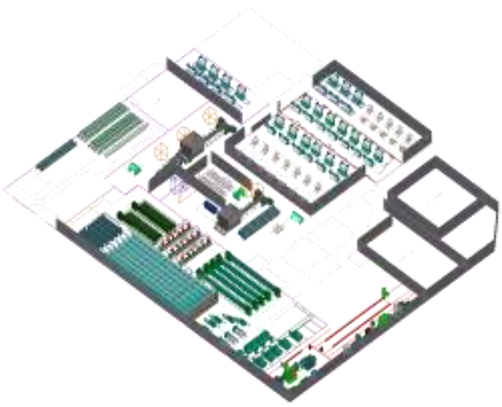

Figure 2. Lay Out of the textile complex

The methodology used in the present study is descriptive, considering that, and according to Hernández, Fernández, and Baptista, (2010), "It is that which calculates and evaluates different aspects, dimensions and components of the subjects to study". We are based on the field research with the purpose of carrying out an interpretative analysis of strategies in order to improve the use of human resources. Arias (2000) defines it as "The collection of data directly from reality, without controlling or manipulating the variables". In the same way, it can be used in the assignment of tasks taking into account the type of machine and the operator based on the previously training taken according to the abilities the operator possesses.

The following chart shows the requirements of human resources according to the type of machine:

Machine	Officer	Official cleaning	Assistant	Official patrolling	Other official activities	Other official activities
Veloz 1	30.87%	26.59%	21.15%	16.95%	6.18%	
Veloz 2	30.87%	26.59%	21.15%	16.95%	6.18%	
Veloz 3	16.15%	6.65%	21.15%	16.35%	8.42%	
Veloz 4	16.15%	6.65%	21.15%	16.35%	8.42%	
Veloz 5	25.29%	2.73%	0.00%	68.86%	3.12%	
Open End 2	12.98%	9.34%	14.09%		20.99%	12.52%
Open End 3	12.98%	9.34%	14.09%		20.99%	12.52%
Open End 4	12.98%	9.34%	14.09%		20.99%	12.52%
Open End 5	12.98%	9.34%	14.09%		20.99%	12.52%
Cardas C-51 1	2.55%	6.71%	0.00%	7.56%	8.19%	
Cardas C-51 2	2.55%	6.71%	0.00%	7.56%	8.19%	
Cardas C-51 3	2.55%	6.71%	0.00%	7.56%	8.19%	
Cardas C-51 4	2.55%	6.71%	0.00%	7.56%	8.19%	
Carda Inglostad 1	0.75%	9.11%	4.99%	2.90%	7.25%	14.40%
Carda Inglostad 2	0.75%	9.11%	4.99%	2.90%	7.25%	14.40%
Carda Inglostad 3	0.75%	9.11%	4.99%	2.90%	7.25%	14.40%
Carda Inglostad 4	0.75%	9.11%	4.99%	2.90%	7.25%	14.40%
Carda Inglostad 5	0.75%	9.11%	4.99%	2.90%	7.25%	14.40%

Table 1 Human requirements according to the type of machine with data from the company.

A Model of Linear Programming for the Assignment of Personnel

Three principal variables were considered given that they are the foundation of the problem, taking into account that in a future the procedure will be used in assignments that involve the human resource, achieving this way costs optimization. It is worth mentioning that other four restrictions were created, which contemplate aspects such as the type of machine, their percentage requirement, the capacity of the operator, and the task to fulfill.

Next, the general model of linear programming (LP) is presented, which has been designed for the purpose of solving the problem of assignment of personnel, as well as the duration of each task dependent of the type of activity (See Table 2).

Estirador 2	10.18%	0.44%		0.83%	4.54%	8.95%	
Estirador 3	10.18%	0.44%		0.83%	4.54%	8.95%	
Estirador 4	3.99%	7.11%		6.64%	3.00%	3.83%	
Estirador 5	10.18%	0.44%		0.83%	4.54%	8.95%	
Estirador 6	3.99%	7.11%		6.64%	3.00%	3.83%	
Estirador 7	10.18%	0.44%		0.83%	4.54%	8.95%	
Estirador 8	3.99%	7.11%		6.64%	3.00%	3.83%	
Estirador 9	3.99%	7.11%		6.64%	3.00%	3.83%	
Conera 1	20.76%	3.47%		0.16%	0.27%	8.68%	6.66%
Conera 2	20.76%	3.47%		4.85%	0.27%	3.99%	6.66%
Conera 3	20.76%	3.47%		4.85%	0.27%	3.99%	6.66%
Conera 4	15.90%	2.46%		2.61%	0.23%	2.65%	6.66%
Conera 5	15.90%	2.46%		2.61%	0.23%	2.65%	6.66%
Conera 6	15.90%	2.46%		2.61%	0.23%	2.65%	6.66%
Conera 7	15.90%	2.46%		2.61%	0.23%	2.65%	6.66%
Trócil 1	17.07%		16.22%	8.18%	18.90%	6.30%	
Trócil 2	17.07%		16.22%	8.18%	18.90%	6.30%	
Trócil 3	17.07%		16.22%	8.18%	18.90%	6.30%	
Trócil 4	17.07%		16.22%	8.18%	18.90%	5.85%	7.19%
Trócil 5	17.07%		16.22%	8.18%	18.90%	5.85%	7.19%

Table 2 Human requirement according to the type of activity with data from the company.

Variables:

X_{ij} Assigning operator i the machine j

Parameters:

C_{ij}= Daily cost of operator i to the machine j

a_{ij}= Requirements of human resource i in the machine j

Where: $i = 1,2,\dots,38, \quad j = 1,2,\dots,38$

Given the data described above, and assuming that the objective consists in minimizing the working cost by time unit, the following model of linear programming can be laid out:

$$Min \sum_{j=1}^{m}\sum_{i=1}^{n} C_{ij}a_{ij}X_{ij} \quad (1)$$

Subject to:

$$\sum_{j=1}^{m}\sum_{i=1}^{n} a_{ij}X_{ij} \leq \mathbf{1} \quad (2)$$

$$\sum_{i=1}^{n} a_{ij}X_{ij} = \mathbf{1} \quad (3)$$

x_{ij} = **0** = ; *i* = {1, 2, 3 ,4, **5**} (4)

j = **{** *open end, cardas, cardas Inglostad, estirador, conera, trocil***}**

x_{ij} = **0** = ; *i* = {6, 7, 8, **9**}

j = **{** *veloces, cardas, cardas Inglostad, estirador, conera, trocil***}**

x_{ij} = **0** = ; *i* = {10, 11, 12, 1**3**} *j* = **{** *veloces, open end, cardas, cardas Inglostad, estirador, conera, trocil***}**

x_{ij} = **0** = ; *i* = {14, 15, 16, 17, 1**8**} *j* = **{** *veloces, open end, cardas, estirador, conera, trocil***}**

x_{ij} = **0** = ; *i* = {19, 20, 21, 22, 23, 24, 25, 2**6**}

j = **{** *veloces, open end, cardas, cardas Inglostad, estirador, conera, trocil***}**

x_{ij} = **0** = ; *i* = {27, 28, 29, 3**0**, 31, 32, 3**3**}

j = **{** *veloces, open end, cardas, cardas Inglostad, estirador, trocil***}**

x_{ij} = **0** = ; *i* = {34, 35, 36, 37, 3**8**}

j = **{** *veloces, open end, cardas, cardas Inglostad, estirador, conera*}

x_{ij} = **0** = *Si i* = 1, 2, 3 … 3**8**} (5)

j = Out of order machine

The objective function (1) is the cost by time unit; the restriction (2) shows us that the level of activity of each operator cannot be above the 100%, due to external factors that may have an effect on the performance of the operator; (3), Only one operator can be assigned to a machine, otherwise the work would result affected, obtaining inferior results than the expected ones; (4) impedes assigning a task to a non-competent operator, reason why they receive previous training; (5) states that tasks cannot be assigned to a non-functioning machine, otherwise it would lead to idle-time in machine-hours, and in man-hours this would bring significant losses to the corporation.

Results

Translating the model in LP Solve, the demonstrating solution (See Image 1) is obtained. As it has been already stated, different authors have proposed linear programming models for a great variety of problems in assignment of personnel, such as Thangavelu (1971) or Dar-El (1978), among others. However, to this day, this models have been scarcely used in practice, due to the difficulty in carrying them out at a reasonable processing time. In many occasions, the model is only used in order to formalize the problem, using diverse procedures. On the other hand, if the laid out model does not generate the desired solution it is still possible employing different tools such as Lingo, Lindo, etc.

According to the previous plan, results are shown considering that carda c-51 and Inglostad work with different operators; whilst in the two following activities, this areas are joined. The labor cost is also shown, whether for one shift or the three, for both cases; it is worth mentioning that this quantities were obtained according to the percentage of amount of covered work, as well as the complete payment without considering said percentage.

Spinning Complex				
Work Area	Number of operators (3 shifts)	Weekly payment (3 shifts)	Number of assistants (1 shift)	Weekly payment (1 shift)
Veloz	9	$9,815.46	6	$3,507.60
Open End	3	$4,553.28	6	$5,712.00
Cardas C-51	3	$1,889.04	3	$982.80

Cardas Inglostad	3	$2,514.3	6	$3,996.00
Estirador	6	$5,954.76	3	$1,533.60
Conera	6	$8,487.93	3	$2,351.40
Trócil	6	$6,438.75	6	$3,782.40
Weekly subtotal	36	*$39,653.52** $61,200.00	33	*$21,730.80** $33,000.00
Weekly total	*$61,384.32*		*$94,200.00*	

Source: Results labor cost-shifts

Spinning complex				
Work Area	Number of operators (1 shift)	Weekly payment (3 shifts)	Number of assistants (1 shift)	Weekly payment (1 shift)
Veloz	3	$3,271.42	2	$1,169.20
Open End	1	$1,517.76	2	$1,904.00
Cardas C-51	1	$629.68	1	$327.60
Cardas Inglostad	1	$838.10	2	$1,332.00
Estirador	2	$1,984.92	1	$511.20
Conera	2	$2,829.31	1	$738.80
Trócil	2	$2,146.25	2	$1,260.80
Weekly subtotal	12	*$13,217.84** $20,400.00	11	*$7,243.60** $11,000.00
Weekly total	*$20,461.44*		*$31,400.00*	

*All the values in this conditions are put up by the LP Solve software.

Conclusions

In reference to the laid out objective, indentifying the potentialities of the human factor of the company, from the laying out of the theory of decision-making, with the purpose of finding new strategies for optimizing this important factor, it has been reached the point to integrate and combine new restrictions within a mathematic model creating another solution. The variables of the human factor, cost of operation and requirements of each machinery will make it possible to reach more benefits and optimal operation results, since in every stage of the process of production the costs that require minimization and resources to optimize are stated implicitly.

Gómez (2008) considerations are worth mentioning. The importance of the resources and capacities to increase the efficiency and effectiveness of the corporation makes reference to the human factor that includes the knowledge, training, experience, communication, and the relationships within the personnel of the company.

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