“Visión de Futuro” Año 9, Volumen Nº16, Nº 1, Enero - Julio 2012
URL de la Revista: www.fce.unam.edu.ar/revistacientifica/
URL del Documento: http://revistacientifica.fce.unam.edu.ar/index.php?option=com_content&view=article&id=274&Itemid=63
ISSN 1668 – 8708
Fecha de recepción: 12/03/2012
Fecha de aprobación: 07/04/2012

DIAGNOSIS OF MANAGEMENT TECHNOLOGY AND ITS ENVIRONMENTAL AND LABOR IMPLICATIONS IN SMEs SAWMILLS - A CASE STUDY

Mario J., Mantulak; Gilberto D., Hernández Pérez; María C., Dekun; Alejandro J., Kerkhoff

Universidad Nacional de Misiones

Facultad de Ingeniería

Juan Manual de Rosas 325, CP 3360, Oberá, Misiones, Argentina

E-mail: mmantulak@gmail.com

“Visión de Futuro” Año 9, Volumen Nº16, Nº 1, Enero - Julio 2012

SUMMARY

The work was carried out in a SMEs timber establishment in the province of Misiones, Argentina. As the objective it proposes to develop a diagnostic method of technology management that would address the relationship between cross-technological factors, labor and the environment. The tasks performed enabled a comprehensive analysis of environmental and labor aspects from the perspective of technology management. As results on the one hand were obtained, recovery of the levels of technological and environmental significance and labor sectors of sawing, drying and remanufacturing, and secondly, through the statistical tool of correlation analysis, we studied the associations between technological factors of the different workstations, and the implications due to environmental impacts and labor. The work done allowed an adequate technological diagnosis, enabling the detection of critical issues regarding technology resources which may be improved, contributing also to the process of making decisions related to technology management.

KEY WORDS: Technological Management; Sawmills; SMEs.

INTRODUCTION

The management of technology in business involves the use of a knowledge group, procedures and expertise that enable better use of technological resources in order to achieve higher levels of productivity and competitiveness. "The technology management includes product technology and process, but also the technologies used in management functions" According to Dankbaar [in Escorsa Castells, P. and Valls Pasola, J., 2005, p.47] (1).

In the context of technology management to be taken into account, both innovations in so-called hard technologies, which have to do with the development of new products and processes, as well as innovations in soft technologies, linked with the functions and organizational structures. This should enable to effectively meet customer requirements and efficiently deal with its competitors, in a creative work environment, participatory and relevant to ensure an attractive economic return in the near future, according to Paredes, expressed in Martinez de Carrasqueño, C et al. (2003).

The technological factors in the area of productive enterprises can be considered from various perspectives. With respect to this work, the definition relevant distinguishes the hard and soft technologies. In this sense Gay and Ferreras express that

> Hard technologies are those that are aimed at the transformation of material elements in order to produce goods and services. Among them one can distinguish two groups: those that produce objects based on physical actions on the matter and those that base their action on chemical processes and / or biological. The soft technologies, also called managerial, deal with the transformation of symbolic elements in goods and services, its product, which is a tangible element, improves the functioning of the institutions or organizations in achieving their goals. [Gay, A. and y Ferreras, M., 1997, p. 10] (2)

In the province of Misiones, of all the establishments about 557 (91%) correspond to small businesses[1] and about 25 (4%) to the medium, which employ approximately 76% of workers in the timber category. The census itself determines that the monthly total raw material used in the timber industry, 90% is implanted forests and 10% native forests, according to the Under Secretary of forests and forestation of the Ministry of Ecology, Renewable Natural Resources and Tourism, in its

1The small sawmills correspond to enterprises with a monthly sawing of less than 600 m^3, and the medium enterprises with a monthly volume of between 601 and 1,900 m^3

first Quadrennial Statistical Compendium Forestry-Industrial Sector, Misiones 1999-2003 (2004).

However their representativeness and significance in the province of Misiones, forestry-industrial SMEs mark deficiencies in technology. This result comes from prominent factors, such as, profitable business cycles are relatively short, distinct lack of policies conducive to technological development, and thus the fact that, in most cases, these businesses have been developed under a management based in a family-type structure.

While there is a tendency to incorporate new technologies, this is manifested as a reactive strategy type, present, usually when there are customer requirements or because of pressure from competitors in the business market. In general, management of technology is not considered a priority in most of the SMEs sector, and when carried out, it is a very simplified, without considering the complexity of the production scenario and its possible trends. In this sense, the actions are based only on the experience of managers and process, in that transmitted by other enterprises, and even due to technology preferences in fashion.

Within the forest industry sector, SMEs, the vast majority of small establishments complete the implementation of technology (equipment, machinery, devices, etc..), Without performing an adequate analysis of the technological requirements depending on production demands. Mantulak et al. explains

> Regarding the selection of equipment, in general, there are two types of situations. The first, relating to the acquisition of equipment with obsolete technology, which has little flexibility when having to deal with unusual demands for products. The second, concerning the purchase of equipment with advanced technology, surpassing the requirements of the production line and consequently the equipment by operating well below their nominal returns. [Mantulak, M., et al., 2011, p.3] (3)

With respect to environmental management in this sector, the implications on the environment are related to the misuse of the soil, generation of waste produced in the various processes of mechanical processing, improper disposal of waste and toxic organic air pollution. According to Mantulak (2005), in an initial environmental review conducted at a SMEs sawmill in the province of Misiones, and with respect to the waste generated, it was concluded, among other things, that it was necessary to study emissions of compounds and particulate materials from the burning furnace and the boiler, draw up a register of waste generated and conduct a feasibility study for the use of generated sawdust.

In terms of hygiene and safety at work, one of the most pressing problems is given by the generation of noise and dust from cutting processes, milling, planing, etc. In a case study in a SMEs sawmill in the province of Misiones, Mantulak states that "The sawmill sector and in particular milling stations do not have noise attenuator elements" [Mantulak, M., 2005, Op.cit. p.67] (4). Another issue little attended to, is related to the risk of fire, not taken into account in most of the mills with their own fire brigade, and the corresponding contingency plan.. Moreover, the use of personal protective equipment (helmet, goggles, safety shoes, respirators, hearing protection, etc.) is not taken into account in many establishments.

In the present study data were obtained from normal operation of the process of mechanical wood processing in the establishment under analysis, which is not possible to apply techniques of controlled experimentation. It is also necessary to use techniques to transcend from the sampled data, to states of generalized situation of production processes analyzed. The application of multivariate analysis techniques, including correspondence analysis, is useful to establish dependency relationships between different variables of each process. According to Salvador Figueras "Correspondence Analysis is a statistical technique that is applied to the analysis of contingency tables and builds a Cartesian diagram based on the association between the variables analyzed" [Salvador Figueras, M., 2003, p. 1] (5).

In the above context, this work is done in a SMEs sawmill processing timber from implanted forests. The tasks are focused on the analysis of technology in the areas of sawing, drying and remanufacturing.. For this one targets the development of a diagnostic method that allows linking technological factors present in the different workstations and their implications on environmental and labor. The scope of work is given in the achievement of a simple, systematic application, and applicable to other SMEs sawmill establishments in the province of MisionesThe results form an interesting basis for the analysis of conditions and technological requirements in the organization, promoting the processes of decision-making related to technology management.

DEVELOPMENT

Materials and methods

For the development of this research work it was planned in such a way which on the one hand, to establish the impacts of the various production processes, both environmental and in labor.. Moreover, analysis of technology management by linking the above impacts with technological factors related to the workstations of each process.

In the first instance, one defines significant environmental and labor aspects for each of the workstations included in each production process. We describe the impact caused by each of the predetermined areas. Next, the report assessing the impact caused by every aspect associated with it and makes the assessment of severity of that impact, then determining a value as a significant factor for each aspect. Together one assigns a rating to the technological, discriminated in soft technologies and hard technologies, linked to each workstation in the different production processes.

Secondly, through multivariate analysis using the technique of multiple correspondence analysis. This tool should enable the analysis of association between each significant aspect, its environmental impact and work, and the level of technological factor to which they are linked.

Factor determining the level of technology for each workstation

It provides a categorization between hard technologies (machinery and equipment) and soft technologies (HRM), assigning to each workstation a recovery (code), by category, using Table No. 1. In the category of hard Technologies to assign the code one has to assess the operational status and the technological element model of production. In the category soft technologies, to assign the code was to assess the level of education, planning and control which one operates the technological element. For this purpose each member of the team does its own subjective assessment on each workstation, and sequentially performing a pooling to define the code to be allocated by category.

Table 1: Table of reference to establish the technological factor

Hard Technologies	Code	Soft Technologies	Code
At the front	1	Very Good	1
Advanced	2	Good	2
Good	3	More or less	3
More or less	4	Bad	4
Obsolete	5	Very Bad	5

Source: Authors'

Determining the significance level for each aspect

At this stage of work there is a description of the impacts of each of the environmental and labor issues, it assesses the significance of the impact and severity associated with it, and finally, determines the impact of each aspect through level of significance. To carry out the tasks one used as the reference method proposed by the authors Hewitt Roberts and Gary Robinson in the book ISO14001- EMS, Handbook of Environmental Management System (1999), this method was adapted to work, incorporating in its analysis labor issues. Below is Table 2, used to describe each of the different impacts, appropriate values of impact, severity and significance level, all associated with each aspect. For this purpose each member of the team does his own subjective assessment on each workstation, and then performs a pooling to define the assessment of impact and severity of each aspect.

Table 2: Determination of the significance level for each aspect

Level of significance of aspects					
Work-station	Appearance	Description of the impact	Impact Assessment	Risk Rating	Significance Level

Source: Adapted from Hewitt Roberts and Gary Robinson [1999]. ISO 14001-EMS, Handbook Environmental Management System ISO 14001-EMS

For the determination of building values and Table 2, we proceed as follows:

1) In column workstation one lists the task sequences for each process.

2) In column appearance, environmental and labor considerations are reflected associated with each of the workstations of each process. For the definition of aspects, environmental and labor is taken as reference established by the author Mario Mantulak in his book The initial environmental review of the timber industry.

3) The description of the impact column describes the impact associated with each aspect in question.

4) The impact assessment column, you assign a value to the impact associated with each aspect, based on questions, evaluated with the number 1 to each yes, and the number 0 for each NO. Depending on the answers, the value to be entered must be between 0 and 5 for each aspect considered. The questions are:

I. Are you associated with the appearance of any legislation, regulation, authorization or industry codes of practice. Or, does the aspect identified imply the use of any harmful, restricted or special substance?

II. Does the environmental aspect linked to the workstation involve a high occupational risk, present or potential, for the worker?

III. Does the environmental or labor to third parties worry? (Government agencies control, work injury insurance, neighbors, customers, suppliers, etc.).

IV. Is it difficult to reduce the impact associated with the environment or labor?

V. Are the appearance and impact clearly associated to some general problems of environmental or occupational health and safety? (Global warming, reduction of the ozone layer, acid rain, deforestation, irrational use of renewable and nonrenewable resources, excessive use of electric power, increased occupational risk, company increased accident rate, etc.).

5) In the risk assessment column, indicating the perceived seriousness value for each aspect identified. One should reflect the effect it has or might look like if uncontrolled. It is used for assigning values to characterize the effects established in Table 3.

Table 3: Table used to determine the valuation risk

Assessment	Risk
1	Slight Effect
2	Consistent Effect
3	Moderate Effect
4	Severe Effect
5	Critical Effect

Source: Authors'

6) The value assigned to each column aspect significance level is obtained by multiplying the impact assessment column by column value risky rating. In Table 4 one sets out the categories according to the range determined by the level of significance.

Table 4: Table used to determine the significance level

Level of Significance (Ranges)	Category	Code
0 – 1	Insignificant	1
2 to 5	Low	2
6 to 11	Medium	3
12 to 17	High	4
18 - 25	Excessive	5

Source: Authors'

Correspondence Analysis

The use of correspondence analysis allows the simplification of data that have difficulty in their description or understanding, which can be seen by a suitable display through the so-called perceptual maps. This tool enables the dimensional reduction and perceptual mapping. As a matter of Hair et al.. "It is an interdependence technique that has become more popular for dimensional reduction and perceptual mapping" [Hair, J., et al., 2007, p. 571] (6).

In this study one determines the position of each workstation for each process, in connection with technological factors and levels of significance. We performed a dimension reduction of the problem through a two-dimensional vector space, where the proximity in the mathematical sense, indicates the degree of association between different workstations, technological factors and levels of significance. Using the statistical technique allows for clear and simple linkages between technological factors present in the workstations, environmental and labor issues, and their implications for workers and the environment. With this it is feasible to perform different crosses of relationships between the factors and aspects studied, allowing mapping of diagnostic technology management, which in turn, link it to the consequences both within and outside the establishment.

Results

Assessment of the level of technological factor and the level of significance

For the assignment of codes (recovery), for hard and soft technologies, of each workstation Table No. 1 is used in. For determination of the codes (ranges of recovery) the level of significance pertaining to labor and environmental aspects linked to each workstation, one uses Table 4.

In Table 5, we illustrate the enhancement of the level of technological factor and the significance level for the sawmilling industry. In this way for example, it can be seen, with respect to technological factor level, fair and poor conditions in the workstation 7; while they are advanced and good conditions in workstation 2.

Table N 5 Table of Technological Factor Levels and of Significance for the sawing industry

SAWING SECTOR															
Workstation	**Technological level Factor**		**Level of Significance** (Environmental and labor)												
	Hard Technologies	Soft Technologies	Water	Power	Raw Material	Gaseous Waste	Solid Waste	Liquid Waste	Chemical Risk	Electrical Hazard	Noise	Thermal Load	Lighting	Fire	Mechanical Risk	Several Risk
1-Storing Area	3	3	1	1	1	2	1	1	1	1	1	1	1	1	1	4
2-Debarking	3	3	1	1	1	2	2	1	1	1	2	2	1	3	3	4
3- Cut with twin saw	2	3	1	1	1	2	1	1	1	1	1	2	1	1	3	4
4- Cut with saw double tandem	2	2	1	4	2	1	1	1	1	1	3	1	1	1	3	2
5- Cut multiple circular saw	3	3	1	4	2	1	3	1	1	1	4	1	1	1	2	1
6-Cutting with simple Circular Saw (blunt)	3	4	1	1	1	1	1	1	1	1	1	1	1	1	2	2
7- Classification area	4	4	1	4	2	1	4	1	1	1	4	1	1	1	4	1

8- Cut Horizontal band saw (planks)	3	4	1	2	2	1	4	1	1	2	4	1	1	1	4	1
9- Cut multiple circular saw (edging)	3	4	1	2	2	1	4	1	1	2	4	1	1	1	4	1
10- Cut Circular Saw simple (separators)	3	4	1	2	2	1	4	1	1	2	4	1	1	1	4	1
11- Storage	4	3	1	1	1	1	1	1	1	1	1	1	1	1	2	2
12-Sharpening workshop	3	3	1	1	1	2	1	1	1	1	2	1	1	5	3	4

Source: Authors'

In Table 6, we report the enhancement of the level of technological factor and the significance level for the drying area. There, on the level of significance, as an example, one has negligible impact conditions and low aspects associated with water, power, solid waste, chemical waste, electrical hazards, mechanical risk and raw materials, waste gas, illumination, respectively, for the workstation 1.

Table 6: Table of Technological Factor Levels of Significance for the drying industry

DRYING AREA																
Workstation	**Technological level Factor**		**Significance Level** (Environmental and labor aspects)													
	TechnologiesHard	Soft Technologies	Water	Power	Raw Material	Gaseous Waste	Solid Waste	Liquid Waste	Chemical Risk	Electrical Hazard	Noise	Thermal Load	Lighting	Fire	Mechanical Risk	Several Risk
1- Fuel (Res. wood)	4	4	1	1	2	2	1	1	1	1	2	3	2	4	1	3
2- Fuel Supply	3	4	1	1	1	1	1	1	1	1	1	2	2	3	2	2
3- Provision of boiler water	3	3	4	2	1	1	1	1	1	2	2	3	2	1	1	1
4- Steam production	2	3	2	3	1	2	1	1	2	1	2	2	2	2	1	2
5- Drying Chambers	2	2	2	4	4	1	1	1	1	2	3	2	2	4	3	3
6- Storage	3	3	1	1	1	1	1	2	1	1	2	3	3	5	3	3

Source: Authors'

Table 7, exhibits the enhancement of technological factor level and the level of significance for each of the workstations in the remanufacturing industry In it, by way of example, one can see, with respect to technological factor level, good and regular conditions in workstation 1 and 2 in that they are advanced and good conditions in the workstation 4.

Tabla 7: Table of Technological Factor Levels of Significance for the remanufacturing industry

REMANUFACTURING SECTOR															
Workstation	**Technological level Factor**		**Significance Level** (Environmental and labor aspects)												
	TechnologiesHard	Soft Technologies	Water	Power	Raw Material	Gaseous Waste	Solid Waste	Liquid Waste	Chemical Risk	Electrical Hazard	Noise	Thermal Load	Lighting	Fire	Mechanical Risk	Various Risk
1-Dismounting of castles	3	3	1	1	3	2	1	1	1	1	2	2	2	1	3	2
2-Cut with band saw	3	3	1	1	3	1	1	1	1	2	3	2	2	1	3	2
3-Brush	3	2	1	2	3	1	1	1	1	2	3	2	2	1	3	2
4-Tongue and groove	2	2	1	3	3	1	1	1	1	2	4	2	2	1	2	2
5-Court simply circular saw	3	3	1	1	3	1	1	1	1	2	2	2	2	1	3	2
6-Packing and storage	3	3	1	1	1	1	1	1	1	1	1	2	3	4	3	3

Source: Authors'

Analysis of discrimination measures

The analysis of discrimination measures indicates the representativeness of each variable according to how sensitive or how discriminative it is in the dimensions of analysis, which in this case are two dimensions. The discrimination capacity of each variable is given by their variability in the dimensions of the analysis, so a variable located on the bisector of the graph of discrimination, or near, indicates that it is significant in both dimensions.

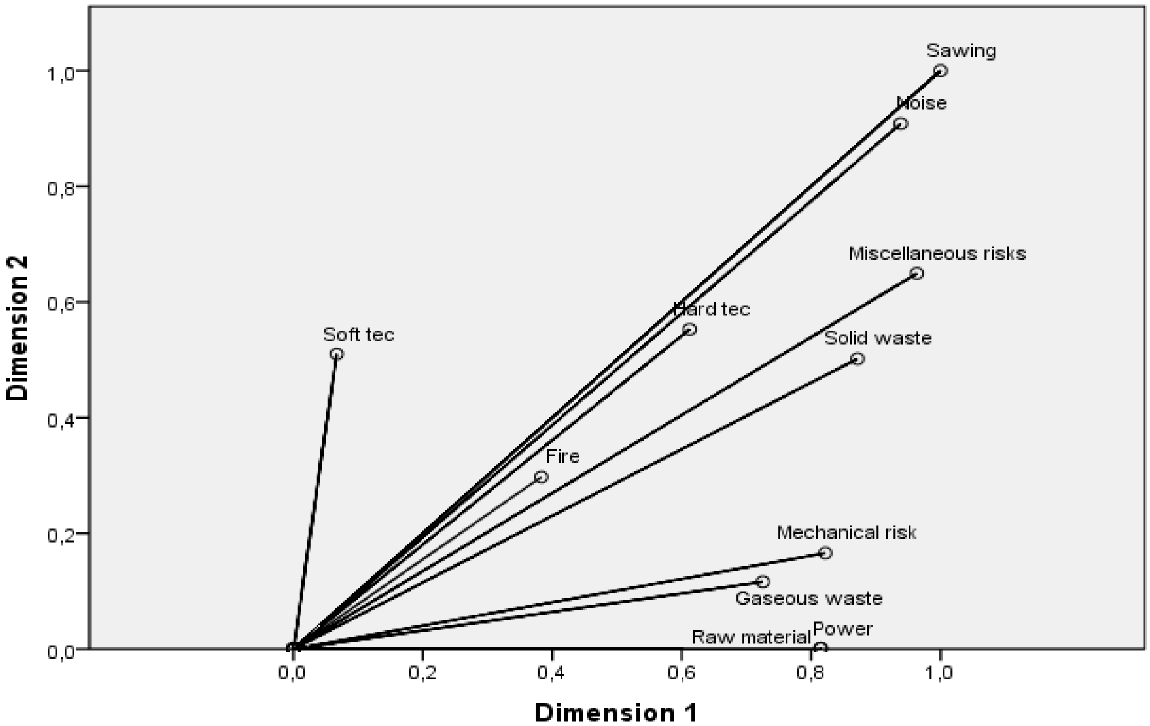
Correspondence Analysis

Through the correspondence analysis one describes, first, the links between workstations, technological, environmental and labor issues.. At the same time, one describes the relationships between the categories of level of technological factor and level of significance, where the distances on the graph, between category points reflect the relationships between them, and besides, the categories are similar or associated represented close to each other.

Description of graphics by sector

Chart 1, shows that in the milling industry, the variables of hygiene and safety at work (HASW) that are significant for the analysis are noise and various fire risks, the most important because of their magnitude (distance from the origin), noise and various risks, while mechanical risk is more associated with dimension 1. Referring to the solid waste environmental variables is more prominent. As for the variables, technological factors show that hard technologies are sensitive in both dimensions while soft technologies are more associated with the dimension two, both with similar magnitudes.

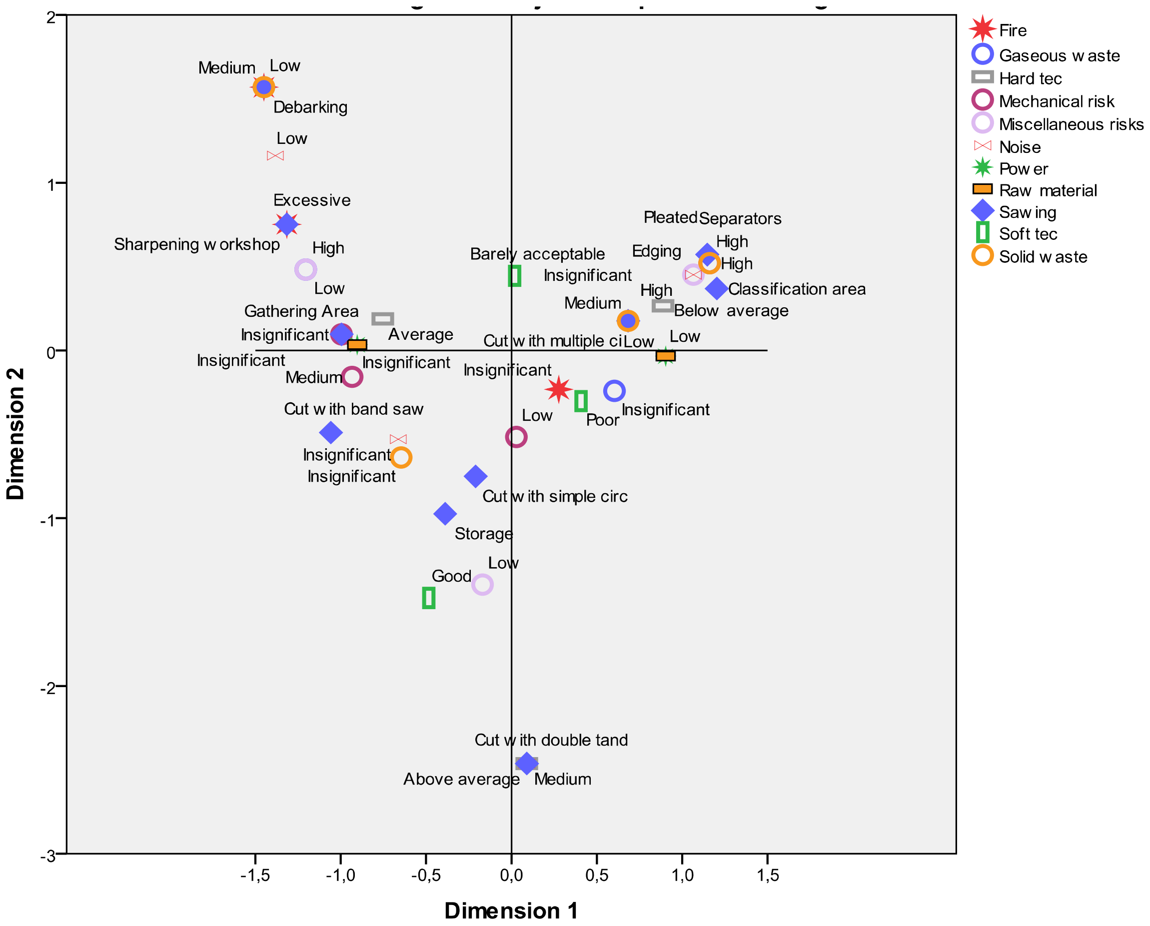
Chart 1: Measures of discrimination between technological factors, environmental aspects and safety aspects (sawing industry)



Source: Authors'

In Chart 2, the centroid indicates that the circular saw cutting stations (5), classification area and marshalling and stored (7), band saw cutting horizontally (8), cut with multiple circular saw (9) and simple circular sawing (10) are associated with high noise levels, located in the first quadrant. The high risk levels are associated with several workstations on the gathering area. (1), debarking (2), cut with twin band saw (3) and sharpening workshop (12) while the highest risk of fire is in the sharpening workshop (12), located in the second quadrant. As the environmental aspects of high levels are associated with solid waste stations and marshalling and stored (7), horizontal band saw cutting (8), cut with multiple circular saw (9) and cutting with sSimple circular saw (10).

Chart 2: Levels of association between technological factors and environmental aspects and safety aspects (sawing industry)

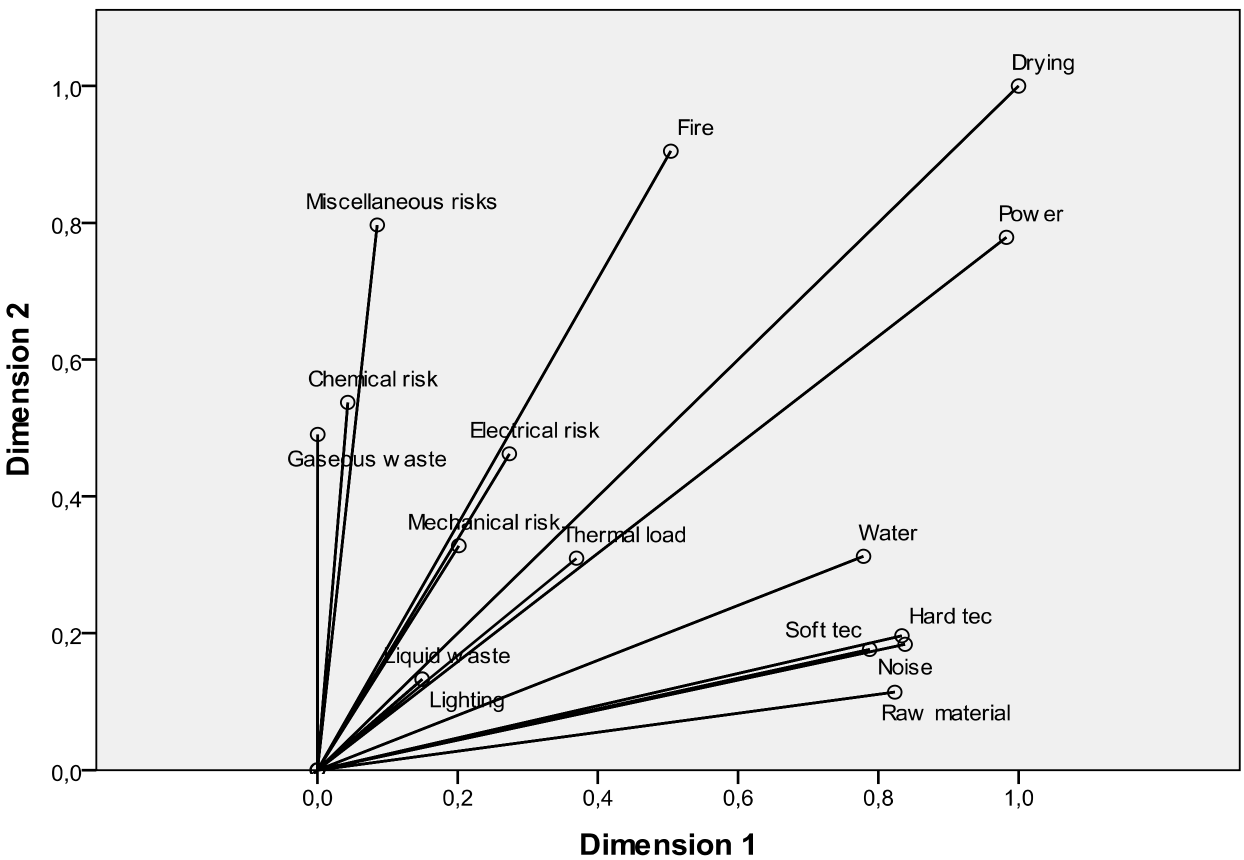


Source: Authors'

Continuing with Figure No. 2, and with respect to technological factors, workstations simple circular sawing (6), classification area and marshalling and stored (7), band saw cutting horizontally (8), cut with multiple circular saw (9) and simple circular sawing (10) are associated with a steady state of hard technologies while stations classification area and marshalling and stored (7) and storage (11) are associated with bad levels of soft technologies. Summing up, the regions of first and second quadrants of the graph are critical in the combination of workstations HASW risk levels and environmental and technological factors.

Figure No. 3 presents the measures of discrimination in the drying, the same can be observed that the variables that discriminate the two dimensions of analysis correspond to fire, power, electrical hazards, mechanical and thermal load risk.

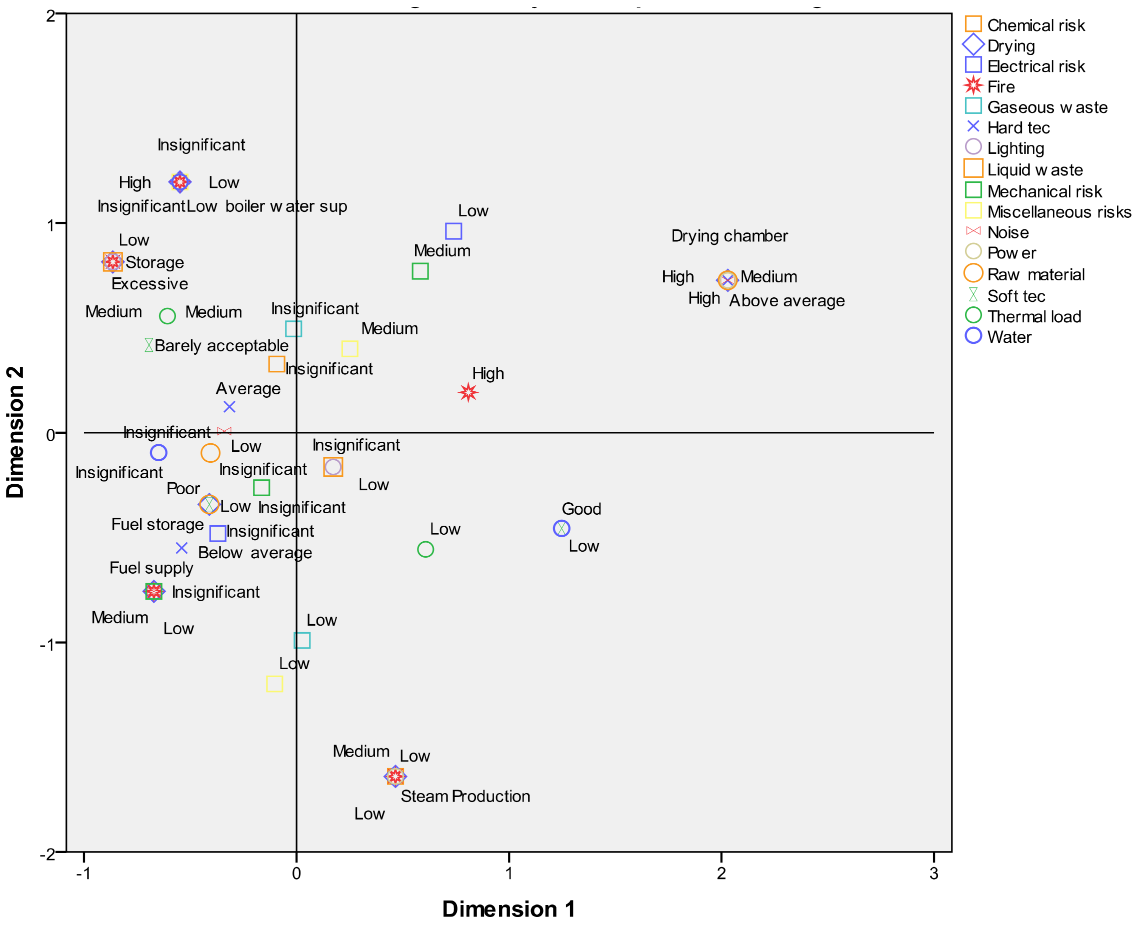
Chart 3: Measures of discrimination between technological factors and envirnmental aspects and safety aspects (drying sector)



Source: Authors'

Graph No. 4, corresponding to the centroid diagram for drying sector. As seen fuel storage stations (1), drying chamber (5) and storage (6) are associated with high risk of fire. Regarding the high energy associated with the drying chambers station (5). Providing water to the boiler (3) is associated with a high level of environmental variable water. Also the fuel storage stations (1) and fuel supply (2) levels are associated with bad and regular technological factors soft and hard technologies. In short, the quadrants 1 and 2 contain centroid diagram partnerships that are critical for analyzing between workstations drying sector HASW variables, environmental and technological.

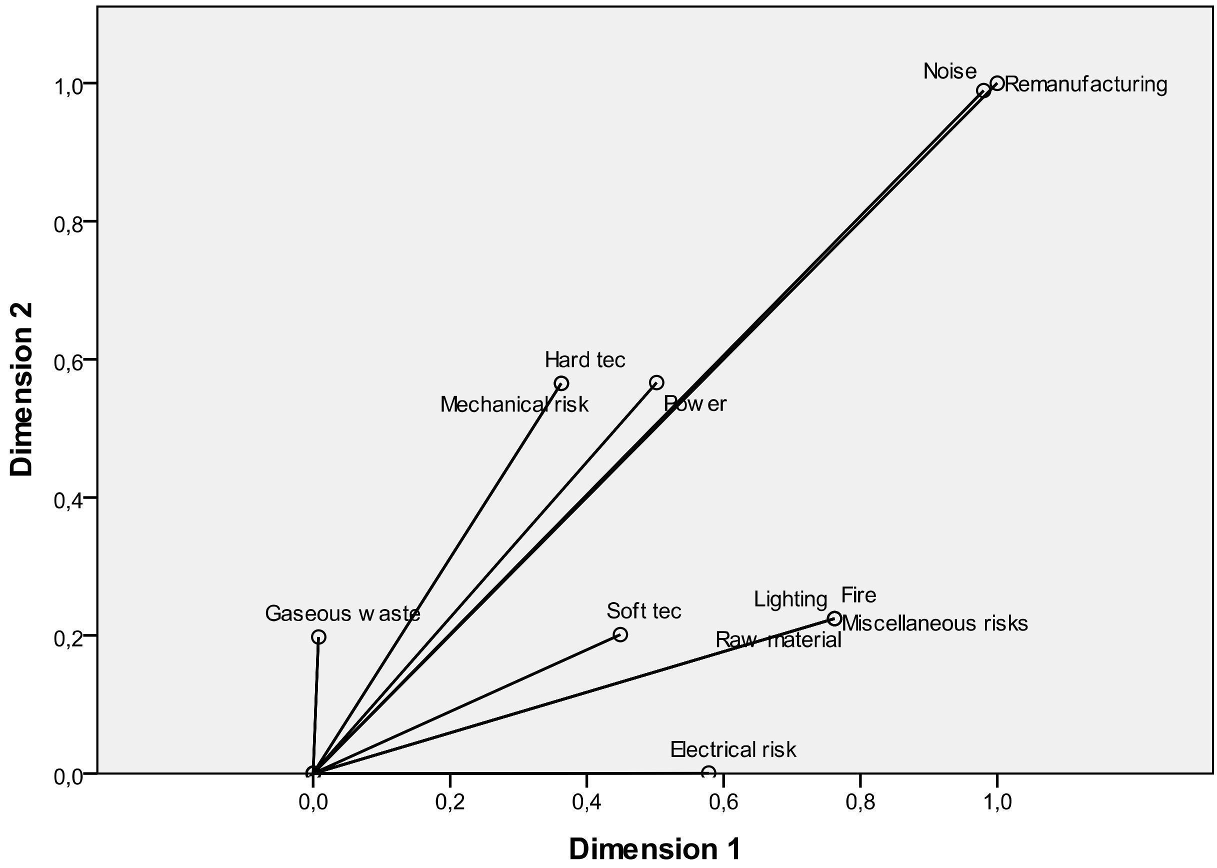
Chart No. 4 Levels of association between technological factors and envirnmental aspects and safety aspects (drying area)



Source: Authors'

Chart No. 5, for the remanufacturing industry, indicates that the significant variables in discrimination workstations are noise, energy, mechanical risk and hard technologies.

Chart Nº 5: Discrimination measures of between technological factors and environmental aspects and safety aspects (drying area)

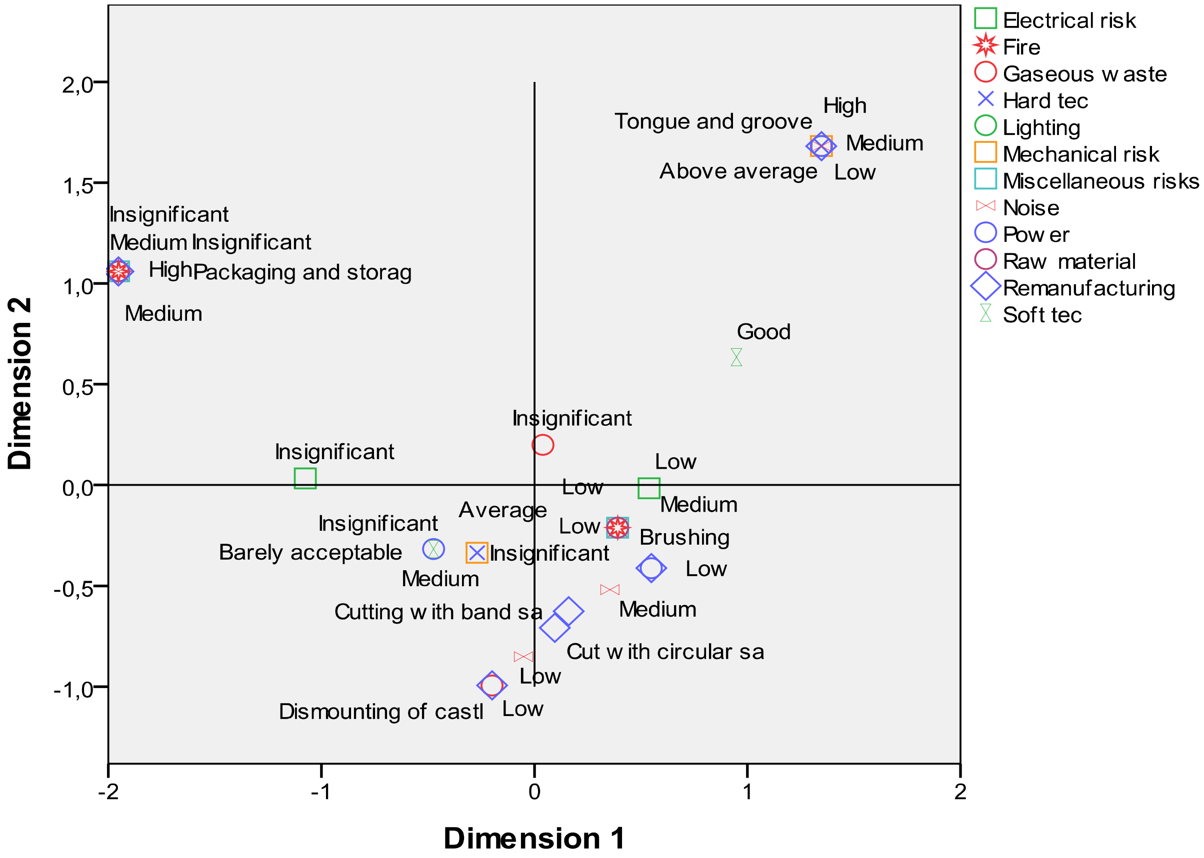


Source: Authors'

Chart No. 6 corresponds to the centroids diagram of the remanufacturing sector, indicates that the station of dovetailing (4) is strongly associated with high noise level, while packaging and storage (6) are at high fire risk of.

Technological factors of both hard and soft technologies are presented as good and fair in the sector. Again, the first and second quadrant of the graph show the stations critical sector as the associated risks.

Graph 6: Levels of association between technological factors and environmental aspects and safety aspects (remanufacturing industry)



Source: Authors'

CONCLUSIONS

The research has produced a comprehensive analysis of production processes linking technological factor levels that make up the various workstations with significance levels of environmental and labor issues, enabling to characterize different types of technological features and capabilities of those who operate them, and through the use of statistical tools were able to integrate and synthesize the existing partnerships between the state and use of technological features and its implications on the employment situation and the environment.

The whole methodology enabled the detection of priority areas according to the factors identified which are necessary when developing strategic actions to encourage improvement of the competitiveness of the analyzed company, and may favor a better position both in the environment, as it pertains to health and safety at work. In this context it is considered appropriate to incorporate into future analysis, aspects related to business productivity.

The development of the research was very positive because the results derived from the application in the production context, represent a contribution to the integral approach to the problems of a local SME sector sawmill, watching their technological, environmental and labor.

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"Visión de Futuro" Año 9, Volumen Nº16, Nº 1, Enero - Julio 2012