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Socio-Economic Profile of Workers in Charcoal Production Units in Brazil

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ABSTRACT

The research was developed in production units of charcoal derived from *Eucalyptus* spp. It is located in the city of Vazante, in Minas Gerais state, Brazil. In this study, we appraised activities related to forestry in nurseries, harvest and in a charcoal production unit. The goals were to survey workers' socio-economic profile and to analyze working condition ergonomics. The worker profile was assessed by questionnaire. The results confirmed the importance of an ergonomic assessment of workplace. The knowledge of socioeconomic profile of workers has assisted the understanding of their cognitions concerning working environment. We suggested objective actions to be taken by the company to mitigate the problems.

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INTRODUCTION

Charcoal production in Brazil is allocated to meet demands of metal and steel industries; and in a large scale, it is used in farming and urban activities. According to the National Energy Balance (EPE 2013), based on the year of 2012, charcoal and firewood consumption corresponded to 9.1% of all domestic energy inputs, therefore amounting for 25,700 x 10^3 tons oil equivalent.

Brazil is the world's largest steel producer and applies charcoal to iron ore use. It is a strong and growing sector, which provides thousand jobs, income and taxes (Brito 2007).

In charcoal industry, working activities are exhausting and carried out under sunshine and noisy environments, shrouded in smoke and dust, often with improper use of equipment and machinery (Lopes, 2013; Instituto Observatório Social, 2011). In addition, the shortage of information on working ergonomics could prevent companies to achieve improved financial profits.

Ergonomics:

Ergonomics is the study of interactions between people and technology, organization and working environment. It aims to propose interventions and projects to improve concertedly safety, comfort, welfare and work-effectiveness (ABERGO, 2004).

The International Ergonomics Association (IEA 2000) divides ergonomics in three sub-areas of expertise. They are:

- Physical: this area is related to human anatomy, anthropometry, physiology and biomechanical characteristics. Relevant topics include material handling, facility layouts of workstations, work demands and other factors such as repetition, vibration, strength and static body posture and musculoskeletal injuries related to work;
- Cognitive: this area concerns with mental processes, being also known as psychological engineering. It takes into account people perception, attention, cognition, motor control, storage and memory retrieval, as well as how these factors affect interactions among humans and other elements of a system. The main subjects are mental workload, vigilance, decision making, skill performance, human error, human-computer interaction and training;
- Organizational: this area assures the optimization of socio-technical systems, including its organizational structure, policies and processes. The main topics are communication, working shift, scheduling and job satisfaction, motivation, management quality, organizational culture as well as teamwork and remote working.

Therefore, ergonomics is a set of sciences and technologies that seek to improve the man and work relationship, in a comfortable and productive manner. It aims to adapt equipment and working

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environment to workers' characteristics, by means of knowledge in human anatomy, physiology and psychology in order to solve problems urged from this relationship (Couto, 1995; Iida, 2005).

Evaluation of socio-economic profile of workers:

Socioeconomic characteristics of workers is an extremely important knowledge for company's success. If a company knows its employees, it may likely keep them satisfied. Happy employees work better, which enhances profits and attract investments for business (Wagner III and Hollenbeck, 1999). It is then formed a virtuous cycle in which all parties benefit.

Siqueira (2003) conducted a study on informal workers' actions that benefit companies, the so-called "organizational citizenship behavior". In this study, the author concluded that cognitions on social exchange perspective with the company precede emotional bonds of employees with their job and the company.

Figure 1 makes a relationship among worker's cognitions, their feeling of affection and citizenship actions promoted by companies.

However, it is not only enough to know worker's conditions. It is indispensable to use expertise to minimize problems and maximize the perceived qualities.

The working environment is equally important. If a disease is an individual manifestation, health situation is a manifestation of the place (Barcelos *et al*. 2002). Considering the Pubmed, Bireme and Scielo databases, ninety-five theoretical or practical studies related to any aspect of health promotion in the workplace were performed in the last decade (Carvalho and Dias 2012).

Structured interviews are used to improve the understanding of social, economic and environmental situation of workers. They are prepared by fully adapted questionnaire, i.e., questions are previously formulated paying attention to the workers' reality. Such caution is taken due to the possibility of comparisons made with the same set of questions besides that differences should reflect distinctions between respondents and not discrepancies in questions asked (Boni and Quaresma 2005).

The questionnaire is the main approach used to survey economic profiles (Braga *et al*., 1996; Fiscarelli and Pinheiro, 2002).

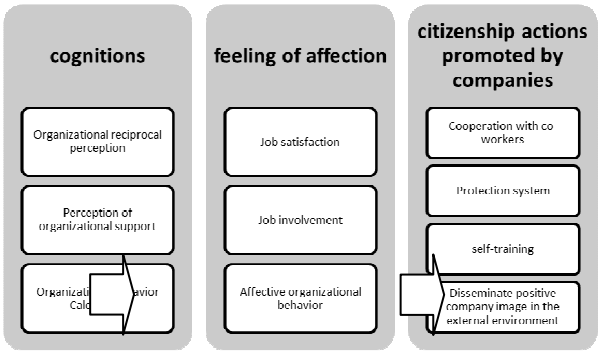

Fig. 1: Post-Cognitive Model of Organizational Citizenship. Source: Siqueira (2003).

In the current study, results showed the relevance of ergonomics evaluations in working environments. Knowing the socio-economic profile of workers assisted in understanding their cognitions about working environment. Furthermore, purposeful actions were suggested to the company to mitigate the encountered problems.

MATERIAL AND METHODS

Study area:

The studied charcoal industry is located in the city of Vazante (Minas Gerais state), which is around 250 km from Brasília, the federal capital of Brazil. It is in a farm with about 50 thousand hectares, which was geographically referenced in UTM format (E 365504 and N 8089757). The land lies on sandy and loam soils.

Based on weather data from production station, average annual temperature ranges in around 22.5 °C, with average maximum and minimum of 32 and 15 °C. The average annual rainfall is 1,100 mm (from 1988 to 2012), with a rainy season from November to March and dry period from May to October. The relative humidity ranges from 25 to 95% and has been classified as tropical humid climate typical of cerrado (savannah-like environment). The mean altitude is 530 meters above sea level (Souza, 2005).

Sampled population:

A survey of 192 workers of forestry activities, nursery and harvesting as well as workers from the charcoal production unit (CPU) in the farm was carried out to assess the socio-economic profile. This number represents 76% of workers employed in the studied process, which ensures a statistical sample quality.

The CPU is composed of rectangular ovens with predominantly mechanized production process and round ovens with predominantly manual production

process. The forestry activity sector is divided into ant control, harrowings, subsoiling, seedling planting, irrigation and herbicide application. The nursery is where seedlings are grown. The harvest is a quite mechanical sector where cut trees are plotted using feller-bunchers, skiders and grapple saws.

Data collection:

The data collected in the assessments were indicators including personal information, social, health and perception of the environment and workplace safety.

Socio-economic profile data were gathered by means of individual interviews to the workers, which were previously structured with the aid of a standardized questionnaire. Questions were asked in the same way for all workers. The following parameters were considered: age, employment period, marital status, number of children, education, addiction (alcohol, cigarette or games), wages, work registration status, working hours, amount of food consumed within the company, pain felt at the working day end as well as any accident sustained during work, most important and uncomfortable protective equipment, perception of environmental factors (lighting, ventilation, noise, temperature and dust) and suggestions for workplace improvement.

The interviews were performed from July to August of 2012. They were applied at the respondent's workplace; therefore, it was possible to get up close to activities performed and to experience the environmental conditions to which they are regularly submitted.

Statistical analysis was carried out through simple arithmetic means and presentation of accurate numbers related to measure data in percentage.

RESULTS AND DISCUSSION

Workers' profile:

Workers from the CPU had mean age of 34.8 years and were predominantly male (73.7%). Among the evaluated sectors, we observed that workers of CPU had lower mean age (32.8 years) than the others did. These values are slightly superior to findings of Faria (2003) and Pimenta *et al.* (2006), which were around 32 years old, studying workers of a battery of surface round ovens (kiln type). Such difference in the values is due to the existing level of mechanization in the studied unit. Moreover, in contrast with Dias *et al.* (2002), we did not find children working in the units.

In comparison with other studies on ergonomics, such as Silva (2003), workers of CPU had on average a 9.2-year experience in the activity performed. Again comparing the studied sectors, we noted that CPU worker had the longest experience time, being of around 12.2 years. It was also superior to findings of Pimenta *et al*. (2006).

Workers ha don average 2.1 children. This rate is higher than Brazilian average in 2012 (1.9 children per woman), published by the OCDE (Organization for Economic Co-Operation and Development). Furthermore, comparing to other studies as Faria (2003) and Pimenta *et al.* (2006), the number of children and reliant people coincided with average number of individuals being of 2.45 and 3.35, respectively.

The highest income was reported by harvest workers, being of 1.9 living wages and followed by CPU workers with 1.4, on average. The other areas described similar incomes, which were around 1.1 living wages. During the interviews, one minimum wage was set to R$ 622.00 (Brasil, 2011), which is equivalent to US$ 371.34, considering an annual average exchange rate of R$ 1.675/ US$ as stated in benchmarks provided by the Commercial Association of São Paulo State (ACSP) in 2012.

The greatest wages of harvest workers may be explained by the work performance expertise, which involves large machinery and high technology use (Table 1).

Table 1: Workers' personal data (average values).

Variable Analyzed	Average per area				General Average
	Harvest	Forestry Activities	CPU	Nursery	
Age (years)	37.5	34.0	32.8	35.4	34.8
Number of Children	2.1	2.2	2.0	2.6	2.1
Number of Dependents	3.1	2.8	2.5	3.2	2.8
Occupation of time (years)	8.3	8.8	12.2	4.1	9.2
Time in the Company (years)	8.0	6.0	8.7	5.0	7.4
Income (minimum wages)	1.9	1.1	1.3	1.1	1.4

Regarding educational level, we noted that 30% workers had secondary school graduation. Harvest workers owned the highest educational level when comparing all sectors, in which 38.6% had graduated from high school. Therefore, we want to emphasize a correlation between this education degree and income rates, since the harvest area has also the highest wages.

Nevertheless, the lowest education levels were reported to CPU workers, from which solely 23% had concluded secondary school. However, our results showed a higher schooling compared to other studies. Faria (2003) ascertained that no worker of charcoal industry had high school degree and only 20% had incomplete secondary school degree. In addition, Pimenta *et al*. (2006) also found similar values.

We can assign these differences to the characteristics of the studied charcoal plants. The quoted studies were performed in manual processes involving round ovens of kiln type. Yet our study has analyzed a prevailing mechanized charcoal plant.

Concerning the area of origin, workers were dominantly from rural areas (64%); however, CPU ones came from the city (52%). Pimenta *et al.* (2006) also found the same trend.

With respect to addiction, 46.8% of workers declared being addicted to something as liquor, smoke or game of chance. Separating by gender, 55% men declared some kind of addiction, such ratio drops to 21.7% for women. Even so, the number of addicted people is high, what is worrisome mainly for tobacco addicts. It is estimated that more than a thousand different substances are present in the absorption of cigarette smoke (Diehl and Cruz, 2010). Among them, nicotine, carbon monoxide, benzopyrene and derivatives, as well as tar and soot. Nicotine triggers the nervous system with a detachment of amines of euphoric action that are responsible for addiction (Fellenberg, 1980). Carbon monoxide gas was also detected by routine measurements of the CPU during charcoal production process (Lima 2013). This is the place where work most of the workers who declared to have any addiction (56.3%).

Pimenta *et al.* (2006) also reported a high number of smoking addicts (25%) and drinking addicts (35%). Table 2 details the findings.

Table 2: Percentage values of variables.

Variable Analyzed			Percentages by area				
			Harvest	Forestry Activities	CPU	Nursery	Total
Sex	Female		0.0	70.9	6.3	75.0	25.5
	Male		100.0	29.1	93.8	25.0	74.5
Laterality	Left-handed		9.3	8.0	5.1	14.3	7.6
	Right-handed		90.7	92.0	94.9	85.7	92.4
Marital Status	Stable union		21.7	25.5	27.4	25.0	24.9
	Married		58.3	43.1	41.9	62.5	48.6
	Separate		0.0	2.0	1.6	0.0	1.1
	Not married		20.0	27.5	29.0	12.5	24.9
	widower		0.0	2.0	0.0	0.0	0.6
Education	Just write the name		0.0	0.0	1.6	0.0	0.6
	Primary School	incomplete	8.8	8.0	13.1	0.0	9.7
		full	15.8	12.0	8.2	0.0	11.4
	Elementary School	incomplete	17.5	28.0	29.5	12.5	24.4
		full	8.8	6.0	16.4	25.0	11.4
	Secondary school	incomplete	10.5	20.0	8.2	12.5	12.5
		full	38.6	26.0	23.0	50.0	30.1
Origin	Rural areas		68.4	78.0	47.5	66.7	64.0
	City		31.6	22.0	52.5	33.3	36.0
Own home			52.6	50.0	57.7	12.5	51.5
Addiction			51.6	34.6	56.3	12.5	46.8

Workers were also questioned about pains at the end of the working day. Around 67.2% workers reported the incidence of pains. Table 3 shows the main complaints of the people who had described such soreness.

Backaches headed the main complaints (30%), followed by pain in the legs (23.4%) and in the arms (18.2%). When contrasting the sectors, we noted that in the nursery, most of the complaints regarded to leg pains (62.5%). Such occurrence derives from working activities being performed standing, in this sector. Pimenta *et al*. (2006) also found a great incidence of backaches (25%) at the end of the job journey.

Table 3: Bodily pain reported by área.

Location of pain	Percentages by area				
	Harvest	Forestry Activities	CPU	Nursery	Total
Head	9.2	27.3	10.9	0.0	14.6
Shoulders	13.8	27.3	4.7	12.5	14.6
Column	26.0	41.8	25.0	25.0	30.2
Arms	6.2	41.8	10.9	12.5	18.2
Legs	1.5	45.5	21.9	62.5	23.4
Feet	0.0	30.9	4.7	12.5	10.9
Chest	1.5	0.0	1.6	12.5	1.6
Abdomen	3.1	1.8	1.6	0.0	2.1
Neck	1.5	18.2	3.1	0.0	6.8

Regarding the workers' perceptions of environmental conditions. we asked them to appraise temperature. noise level. amount of dust. cooling and lighting of the workplace. They informed us excessive dust is the main item that causes certain discomfort in the environment. All nursery workers pointed it as critical and highlighted the closeness of circulation areas of people and car parking lot as the main sources of dust. both located within the space used for seedling production.

Temperature appraisal was completely different among evaluated sectors. While workers from harvest. forestry activities and nursery pointed temperature as ideal. CPU workers defined as high or extremely high. Such outcome was already expected

once the CPU area is full of ovens. Timóteo (1999) also highlighted such complaint.

Table 4 shows results for the environmental factors analyzed.

Table 4: Workers' perceptions regarding environmental factors.

Environmental factor	Rating	Percentages by area				
		Harvest	Forestry Activities	CPU	Nursery	Total
Lighting	ideal	77.1	100.0	50.0	100.0	79.7
	deficient	22.9	0.0	50.0	0.0	20.3
Ventilation	ideal	66.7	87.5	39.6	100.0	66.2
	deficient	33.3	12.5	60.4	0.0	33.8
Temperature	ideal	77.1	71.4	42.0	80.0	63.8
	very high	20.8	24.5	40.0	20.0	28.3
	excessively high	2.1	4.1	18.0	0.0	7.9
Noise	ideal	30.8	26.7	26.7	33.3	28.2
	excessive	69.2	73.3	73.3	66.7	71.8
Dust	ideal	19.5	2.6	4.3	0.0	8.5
	excessive	80.5	97.4	95.7	100.0	91.5

Workers were encouraged to suggest improvements in their working environment. It was done openly and each sector had diverging requirements. Around 62.5% of workers of forestry did not suggest any change; the others suggested the adoption of carts to transport seedling trays. improvements in mini cuttings' planting and equal treatment amongst employees. In the harvest sector. 35.4% did not have any suggestions. Among the others. 12.3% suggested incentive measures to bind work teams; 10.8% proposed the renewal of machines; another 10.8% were suggestive of improving the air conditioning system of the machines; and 7.7% hinted at wage raise.

There was still suggestions on wage isonomy. as well as improvements of means of transportation used within shift change and vehicle lightening with 6.2% each item. The improvement of meals' quality was also cited for 4.6% workers. Table 5 details all suggestions offered by workers.

Table 5: Suggestions made by employees of CPU.

Suggestion	Aumont (%)
No suggestion	32.8
Control dust and smoke	21.3
Salary improvement	21.3
Lighting improvements	6.6
Safety oversight improving	4.9
Field construction	1.6
Positioning the vertical line	1.6
Review of working hours	1.6
Availability of sunscreen	1.6
Guard available against insects	1.6
Ladies room construction	1.6
Improve the mask	1.6
Tractor with cabin for barrelamento ovens	1.6

Table 6: Suggestions made by employees of the Nursery.

Suggestions	Aumont (%)
No suggestion	62.5
Cart to transport trays	12.5
Equality in dealing with people	12.5
Improved mini planting technology stake	12.5

Overall. 15% of workers reported having experienced some type of work accident. The harvest sector is the highest with a rate of 31%. On the other hand. none of the nursery workers reported any occurrence. Among the harvest workers who claimed they had suffered accidents. 52.9% showed carelessness as accident's cause. Working pressure by supervisors was identified as the cause for 11.7% of the victims. The lack of machine maintenance was cited by 5.9%.

Injured workers from the forestry pointed out natural factors and means of transportation as causes of accidents. 50% in each case. Yet for injured people in CPU. working under pressure was the cause in 67% of the cases and lack of maintenance or machine tools accounted for 33% of cases.

Final Considerations:

The workers are mostly men with an average age of 34.8 years and with monthly income of 1.4 living wage. Number of children of them is slightly above the national average.

It was characterized an important average wage gap (72.7%) among analyzed sectors. However. within the same area. there is little wage variation. even among workers with educational differences. Workers noticed it as a lack of incentives for training.

It was observed large number of workers that declared having some kind of addiction. These cases deserve special attention from the company organization. Most workers complained of any pain at the end of workday. The main complaint was backache. For these cases. it is required specialized medical care.

The workers showed their perception of the work environment and safety equipment use. Most of the complaints regards to excessive dust and smoke. The most troublesome protective equipment was the mask. which is the one that protects them from those issues. The workers could freely outline suggestions for working environment improvements. At this point. various tips have been made. for example. improving lighting for evening activities and sunscreen provision. Nonetheless. we observed a significant variance in the needs amongst sectors.

As objective actions. we suggested to the company to encourage workers to improve schooling; to support those who claimed some kind of addiction; to offer medical assessment for those who reported some sort of chronic pain; to carry out contraceptive and family planning campaigns; to perform specific studies aimed at reducing the amount of dust and smoke. especially in CPU sector.

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