Empowerment, Technology and Safety in mining companies

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Abstract

In the global mining industry are carrying out great advances which have an impact in work. The objective of this research was to describe the levels of safety behavior; empowerment and technology use in Ecuadorian mining companies and analyze the impact of empowerment and technology on safety behavior. The research design was cross sectional and the sample was composed of 403 employees. We achieve a confirmatory factor analysis and two hierarchical multiple regressions. The results reveal high means of empowerment, safety behavior and medium levels of technology and also that empowerment dimensions and technology factors influences the Safety behavior.

Introduction

Industrial accidents have high rates especially in developing countries. According to the International Labor Organization (ILO, 2015) every 15 seconds, a worker dies from a work-related accident or disease, every 15 seconds, 153 workers have a work-related accident and every day, 6,300 people die as a result of occupational accidents.

The Ecuadorian government is implementing the change of the productive matrix. In 2000, as a part of reforms for improvement its economy, Ecuador officially introduced the American dollar as its national currency. This becomes the economy in an attractive to avoid the currency risk, inflation instability, problems frequently of the Latin America countries. According to Cedeño (2015), the advantages of mining sector in Ecuador additional to dollarized economy, are easy access to airports and seaports, low energy costs and easy access to water, among others.

In Ecuador, the promotion of mining sector taken part of new government economic strategies to promote the attractiveness of new economic sectors, but in one hand the new investors could benefit on the dollarized system, the mineral potential but on other hand, they should faced the tax rates, economic changes and legal requirements.

Ecuadorian mining production is located in the order of USD 462.46 million, according to Central Bank statistics (Araujo, 2014; Fierro, 2015) in 2013 Ecuador exported 15.63 tons of gold. Most of the mining large-scale projects in Ecuador as Mirador, Fruta del Norte, Loma Larga or Río Blanco, are in exploration phase, but the small and medium mining keep their operations.

In this study we describe three constructs such as the psychological empowerment, the safety and the technology in three Ecuadorian companies, in the context of mining reality in Ecuador. The psychological empowerment is an intrinsic motivation manifested in four cognitions reflecting an individual's orientation to his or her work role: meaning, competence, self-determination, and impact. Meaning is the significance of working; meanwhile Competence is a belief in one's capability to perform work activities with skill; for its part, Self-determination is a sense of initiating actions and Impact is the degree to which one can influence strategic, administrative, or operating outcomes at work (Spreitzer, 1992).

The safety behavior according (Neal, Griffin and Hart, 2000) are behaviors about the safety in workplace, that clearly are influenced by employee views, perceptions and organizational culture. In addition safety behavior determines the compliance of results and performance, aligned to organization plans.

In the global mining industry are carrying out great advances in automation, robotization and updating of technologies, which have an impact in changing processes, organizational dynamics and also have their consequences on the behavior and culture of work, for that reasons we considerer combine the empowerment, safety behavior and technology. According to Lynas & Horberry (2011) there are a deep relation between automation and Safety, because the automated systems are safe and let the companies pointing a sustainable work.

Some tendencies in automation in mining industry, that changing the sector, according to Mieli (2015) are: 1. Use information systems to achieve data integration and user custom aggregation, 2. Solve the lack of integration between plant information and energy information; 3.Technologies Internet on the ground, 4. Operation and centralized control; 5. Wireless; 6. Autonomous systems; 7. Image and video as tools for process.

From this theoretical and contextual perspective we considered the contribution of this paper, which has the objective to describe the safety behavior, empowerment and technology use and analyze the impact of empowerment and technology on safety behavior, in Ecuadorian mining companies, as contribution to a new field to explore in Latin America.

METHOD

Participants

The research design was cross-sectional and the study used quantitative collecting and analyzing techniques. The research using an incidental sample of 403 employees of three mining companies at Ponce Enriquez canton, located in the Azuay Province, Ecuador.

Questionnaire

The Survey included 1- the Safety behavior scale (Neal, Griffin & Hart, 20002); 2- The psychological empowerment (Spreitzer, 1995) and a new technology scale in testing phase.

a-Safety behaviours

According to Andrei, Griffin & Ochoa (2015) the safety behaviours (safe working) subscale consists of 8 items from Neal, Griffin and Hart (2000). The first four items assessed individual compliance with safety procedures and the second four items measured the extent which individuals participated in safety related activities.

b-Psychological empowerment

The four dimensions of empowerment were measured with self-report using a seven-point Likert response format (Spreitzer, 1995). Sample items include "The work I do is meaningful" (meaning), "I am confident about my ability to do my job" (competence), "I have significant autonomy in determining how I do my job" (self-determination), and "My impact on what happens in my department is large" (impact).

c-New technology scale

The technology scale in mining (in pilot phase) tries to measure the importance of technology in mining operations, in two dimensions such the promotion and the prevention. A first dimension prevention, includes items of technology and automation dimension, and comprising all those aspects to facilitate safety workplace. In the second dimension, promotion technology, we try to measure the influence or impact of technological upgrading in organizations and the attitude of collaboration toward safety. The scale has 10 items that were selected from a larger scale. The original scale had 15 items, and five factors such as robotics items were eliminated by the absence of these processes in companies studied.

Procedure

The University of Western Australia created the main questionnaire (Andrei, Griffin,Cham, Opacic, Diaz & Ochoa, 2015) . In Ecuador, we traduced the Safety behavior scale (Neal, Griffin & Hart, 20002) to Spanish; add the Spritzer (Spreitzer, 1995) empowerment scale and design the technology scale. We contacted the employees through a cooperative group of small and medium mining companies, producers of silver and gold, a Cooperative Bella Rica

http://bellarica.org/index.php/quienes-somos/la-cooperativa. The group of researchers collected the data in Ponce Enriquez mines in January 2014, and the process the results between March and July 2015.

Analysis Techniques

Regarding quantitative techniques, we use descriptive and inferential techniques. In the first phase, the study will test the validity and reliability of scales through a exploratory and confirmatory factor analysis and in the second we carry out two hierarchical multiple regressions. We used SPPS software and LISREL 8.80 (Jöreskog & Sörbom, 2006).

RESULTS

We complete an exploratory and confirmatory factor analysis for the three scales the Safety behavior scale (Neal, Griffin & Hart, 20002), the psychological empowerment (Spreitzer, 1995) and a new scale of technology in testing phase, that represented their hypothetical structure. We carry out a confirmatory factor analyses (CFA) to assess the construct validity of the scales using the scaled Satorra-Bentler (1994) index (χ^2_{S-B}), the root mean square error of approximation (RMSEA) , the nonnormed fit index (NNFI), and the comparative fit index (CFI). All the fit indices were above the cut-off points that are considered indicative of a good fit (see de table 1)

Table 1 Fit indices Confirmatory factor analyses (CFA)

Variable	χ^2_{S-B}	*df*	RMSEA	90%CI RMSEA	NNFI	CFI
Empowerment	170.170	48	.079	.0668-0.092	.948	.963
Technology	136.109	34	.086	.071-0.102	.936	.952
Safe working	29.150	19	.036	.000-.061	.990	.993

Note. χ^2_{S-B} = Satorra-Bentler scaled chi-square; *df* = degrees of freedom; RMSEA = Root Mean Square Error of Approximation; NNFI = Non Normed Fit Index; CFI = Comparative Fit Index.

The analysis of reliability for the three scales (see table 2) show good levels of The Cronbach alpha. In Psychological empowerment scale, the Cronbach alpha reliabilities for the four dimentions were adequate (meaning, a=.789; competence,

a =.671.; self-determination, a = .695; impact, a = .757). The Cronbach alpha reliabilities for the Safety behavior scale (Neal, Griffin & Hart, 20002), were adequate (compliance, a= .; participation, a =) and technology also were adequate (prevention, a = .773; promotion, a = .725). In relation to Technology scale the reliability analysis, for the first factor, show a α de Cronbach good level of 0,773, and in the second factor, the α de Cronbach good level of 0,725. The reliability analysis for the complete mining technology scale, show a good level of α de Cronbach of 0,831 (see table 2)

Table 2. Means, standard deviations, and correlations between the study variables.

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Variable	*M*	*SD*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*
Empowerment										
1. Meaning	6.342	1.020	.789							
2. Competence	6.426	.7817	.552**	.671						
3. Self determination	5.533	1.366	.356**	.453**	.695					
4. Impact	5.629	1.245	.429**	.484**	.478**	.757				
Technology										
5. Promotion	3.533	.841	.162**	.096	.170**	.280**	.773			
6. Preventions	3.453	.830	.106*	.034	.101*	.219**	.622**	.725		
Safe working										
7. Compliance	4.619	.587	.395**	.286**	.103*	.244**	.277**	.228**	.779	
8. Promotion	4.426	.604	.294**	.324**	.214**	.284**	.347**	.354**	.541**	.665

Note. M = Mean; SD = Standard Deviation; Cronbach's alphas for each variables are reported on the diagonal; * = p < .05; ** = p < .01; N = 403.

Related to the descriptive results (see table 2), we comment the three scales. Safety behaviors (safe working) subscale shows high means, the safety compliance (4,62) and safety participation (4,43). For its part the four dimensions of psychological empowerment, demonstrates high scores, in meaning (6.34/1.02); competence (6.43/.78); self-determination

(5.53/1.37) and impact (5.63/ 1.24). However the technology scale reveals medium levels of Promotion and prevention factor, due to the low level of technology and automation in the surveyed companies

With the intention of analyze the impact of the dimensions of empowerment and technology on safety behavior, we conducted two hierarchical multiple regressions. In one we used as independent variables the empowerment dimensions and technology factor, and as dependent variable the safety behavior, compliance. And in the other, the independent variables were the empowerment dimensions and technology factor and the safety behavior, participation ,as dependent variable (see Table 3). The stepwise method was used.

The results of the hierarchical multiple regression analysis with empowerment dimensions and technology factors as independent variables and the safety behavior, compliance, as dependent variable, emphasize that the meaning and promotion technology factor affecting the Safe working compliance. Meanwhile the results of hierarchical regression analysis with the empowerment dimensions and technology factors as independent variables and the safe conduct, participation factor as a dependent variable, show the influence of meaning, competence and impact empowerment dimensions and promotion technology on safe working participation

Table 3 Hierarchical Regression Results

Variables	Safe working compliance			Safe working participation		
	B	**SE**	**β**	**B**	**SE**	**β**
Intercept	2.768*	.186		1.839*	.247	
Step 1: Empowerment						
Meaning	.207*	.026	.359*	.062*	.032	.104*
Competence				.175*	.043	.226*
Self determination						
Impact				.017*	.026	.035*
Step 2: Technology						
Promotion	.153*	.032	.219*	.111*	.041	.154*
Preventions						
R	.450			.500		
R^2	.203			.250		
F	50.794*			26.421*		

Note. B = Unstandardized coefficients; SE = Standard errors associated with the coefficients; β = Standardized coefficients; * = $p < .001$; N = 403.

Discussion

The safety compliance as well the safety participation have high levels in the sample, similar to results finding in Asian mining countries (Andrei, Griffin, Wang, & Choe, 2014) among other factors because the similar characteristics in developing countries in both regions, but more studies are need to deepen the particularities in each country.

In relation to the psychological empowerment, we found high scores, especially in the meaning and competence dimensions. The meaning and competence influences the job satisfaction process as well the results in organizations (Hackman & Oldham, 1976; Bakker, Van Veldhoven, & Xanthopoulou, 2015), and also contributes to build empowerment and confidence inside the groups and organizations. Within empowerment dimensions, is highlighted the value given by workers to the meaning of working, a traditional psychological construct (MOW, 1987; Harpaz, & Fu, 2002; Schnell, Pollet & Hoge, 2013) that incorporate the high importance and centrality given to their work by the miners (Ochoa Pacheco, 2012), shared values, goals, duties and rights at work.

As Wilpert (2009) pointed out technological innovation has always been an important factor of change in work and even more, as a result of the introduction of new information technologies (NIT) and globalization. Our study focuses on the importance of individual's behavior toward changes because of technology, competences and the meaning of working. In line with Armstrong and Laschinger (2006) there is a relation between structural empowerment and safety. In our research even though we use psychological empowerment, we found also an influence of empowerment and technology in safety. These finding let to open the perspective about the influence of individual elements as Self efficacy (Bandura, 1982) and all empowerment dimensions but also social and contextual factors. Within these contextual factors, the technology is called to be a decisive factor in the transformation of mining organizations (Lynas & Horberry, 2011; Horberry, Burgess-Limerick, & Steiner,2015)

The technology scale is a contribution to study the relation safety, behavior and technology, and reveals the low level of this aspect in the companies where the study was conducted. The successful Technological process and automation requires the participation, positive values and attitudes (Arancibia, Donoso, Venegas, Cardenas, 2015) and commitment of employees.

We consider that although the mining sector in Ecuador has not reached a high level of development, this kind of safety and behavioral studies, contributes to increases the knowledge regard to Work safety and Organizational Behavior bonds and raises the awareness of the importance of cultural models, human perspectives and behavioral research in safety and risk

plans. As Guldenmund (2000) considered, the empirical research on safety climate and safety culture has developed considerably, but in the future we hope that will be more interest in studies addressing safety, organizational behavior and technology in mining sector in Ecuador and Latin America.

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