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EXPLORING EMOTIONAL INVOLVEMENT IN WORKPLACE BY APPLYING ARTIFICIAL NEURAL NETWORKS: EUROPEAN STUDY

The current worldwide economic situation has made it necessary to reassess the human resources management to facilitate the complete integration of the individual in his/her immediate working environment — known as job involvement. Current research aims to establish a model to predict the emotional involvement level of European employees in the workplace according to certain personal, working, attitudinal and well-being factors. For this purpose, the use of alternative econometric methods is proposed: the artificial neural network — ANN.

Keywords: emotional involvement, working conditions, employees, artificial neural networks, sensitivity analysis, Europe.

M54, M12, J29, C45.

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ДОСЛІДЖЕННЯ ЕМОЦІЙНОЇ ЗАЛУЧЕНОСТІ В РОБОТУ ІЗ ЗАСТОСУВАННЯМ МЕТОДИКИ ШТУЧНИХ НЕЙРОННИХ МЕРЕЖ: ЗА ДАНИМИ ЄС

У статті показано, що чинна економічна ситуація в світі вимагає перегляду методів управління людським капіталом для забезпечення інтеграції особи в безпосереднє робоче оточення, відомої як залученість у роботу. Розроблено модель прогнозування рівня емоційної залученості європейських працівників відповідно до різних особистих, робочих, психологічних і побутових чинників. Для цього використано альтернативний економетричний метод — штучних нейронних мереж.

Ключові слова: емоційна залученість у роботу, робочі умови, співробітники, штучні нейронні мережі, аналіз чутливості, Європа.

Табл. 2.

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ИССЛЕДОВАНИЕ ЭМОЦИОНАЛЬНОЙ ВОВЛЕЧЕННОСТИ В РАБОТУ С ПРИМЕНЕНИЕМ МЕТОДИКИ ИСКУССТВЕННЫХ НЕЙРОННЫХ СЕТЕЙ: ПО ДАННЫМ ЕС

В статье показано, что экономическая ситуация в мире требует пересмотра методов управления человеческим капиталом для обеспечения интеграции личности в непосредственное рабочее окружение, известной как вовлеченность в работу. Разработана модель прогнозирования уровня эмоциональной вовлеченности европейских работников в соответствии с различными личными, рабочими, психологическими и бытовыми факторами. Для этого использован альтернативный эконометрический метод — искусственных нейронных сетей.

Ключевые слова: эмоциональная вовлеченность в работу, рабочие условия, сотрудники, искусственные нейронные сети, анализ чувствительности, Европа.

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Introduction. Armstrong (2005) reports that an organization is an emotional place because any experience in the labour context is saturated with emotions. Managing emotions in a workplace is no longer a peripheral element, but has been transformed into an important parameter in strategic management. It is in this spirit that the proper management of emotions enables managers to know "what" and "how" individuals feel in their workplace, contributing to effective achievement of objectives and, in particular, to emotional involvement as a means of achieving the so-called "paradise of organizational harmony" (Gorrone, 2008). According to Fernandez-Aguado (2004), in order to intervene in business reality through emotions and feelings, it is necessary to conceive of an organization as an "anthropomorphic paradigm", i.e. depending on certain types of behaviors. This is the idea that inspired the management models known as "Feelings Management" or "Will Management". The author considers that feelings and moods have a multiplying effect on the potential, which may be available to the organization, and advocates for achieving a fundamental balance between employees' and employers' reason, feelings and state of mind.

A theoretical framework. Job involvement represents the degree to which job performance affects an employee's self-esteem (Lodahl & Kejner, 1965). Current research focuses its interest on this dimension of the "performance-self-esteem contingency" (Brown, 1996; Saleh and Hosek, 1976; Gurin, Veroff and Feld, 1960), which will be called emotional involvement. Emotional involvement implies a process where objective and subjective elements such as tasks, responsibilities, feelings and job performance all interact with each other, generating involvement to a greater or lesser degree, which ultimately affects psychological well-being and self-confidence. The analysis of the emotional dimension of job involvement is in accordance with the studies of Feldman and Blanco (2006). These authors highlighted the importance of efficient emotion management in organizations, given that emotions play a social role affecting the work environment in many ways. According to Gonzalez and De Elena (1999), when people try to satisfy their needs for self-esteem through work, this brings about involvement as a result. Emotional involvement is an affective reaction — and consequently attitudinal — in the adaptation process of employees to a specific work situation.

A multifactors approach to involvement in workplace. 3 types of elements are related to attitudes like job involvement: individual, organizational and working and, finally, outcome factors (Rabinowitz and Hall, 1977). In the first place, the individual approach analyses how an employee has certain individual characteristics, which predispose him or her to be more or less involved. Secondly, the situational approach centres on the fact that employees react to a set of organizational and working variables — the type of contract, salary, pace of work, monotony, type of business sector and so on — affecting their degree of job involvement. The third approach analyses if job involvement is related to other cognitive and emotional variables such as job satisfaction, motivation, organizational commitment or stress. In summary, job involvement, like most attitudes in a workplace, could be considered as the result of combination of individual, attitudinal and situation-related variables.

In the first approximation, some research shows greater predictive power for individual variables than for working or organizational variables with respect to job

involvement (Hollenbeck, Connolly and Rabinowitz, 1987). Other authors claim that individual variables are just as important as situation-related factors (Elloy, Everett and Flynn, 1995). Finally, other studies give greater weight to labour factors and the organizational context for the predictability of job involvement (Elloy, Everett and Flynn, 1995; Rabinowitz, Hall and Goodale, 1977; Rabinowitz and Hall, 1977). In the following sections, a bibliographic review is developed following the approach of Rabinowitz and Hall (1977).

1. *Individual approach.* The individual characteristics related to job involvement are both demographic factors (age, gender, level of education, marital status etc.) as well as personality traits: self-esteem or sense of responsibility (Bowling, Beehr and Lepisto, 2006; Brown, 1996). Focusing solely on demographic factors, Brown (1996) notes the poor predictability of job involvement in the variables such as age, sex, marital status or length of service, and the author concludes that an involved person cannot be identified exclusively by demographic factors. However, Carmeli (2005) argues exactly the opposite.

2. *Situational approach.* The quality of working life is presented as the ultimate aim of the XXth century organizations, because it leads to the achievement of organizational goals and generates competitive advantages (Igarria, Parasunaman and Badawy, 1994) by ultimately affecting workers' well-being. Empirical literature on job involvement — such as an individual's adaptive response to working conditions — has focused its interest on 5 basic job dimensions of the Hackman and Oldham model (1975) which deals with the characteristics of a workplace: task variety, task identity, task significance, job autonomy, and feedback (Elloy et al., 1995; Igarria, Parasunam and Badawy, 1994; Lorence and Mortimer, 1985; Rabinowitz, Hall and Goodale, 1977; Hackman and Oldham, 1975). In 1996, Brown updates the profile of an individual involvement as defined by Rabinowitz and Hall (1997) and Lodhal and Kejner (1965). Brown (1996) describes how an involved person considers that his/her job is highly significant and challenging, performs complex tasks which require a great variety of skills and he or she thinks that the result of their work is in the final product or service — task identity. The individuals involved collaborate actively in determining performance indicators, have positive relationships with their immediate superior and great autonomy. Finally, Tummers et al. (2002) claim that job involvement is affected by employees' discretionary power for developing tasks. On the other hand, social support is also an important variable related to job involvement. In early conceptualizations of job involvement, social support is shown as its causal variable (Chen and Chiu, 2009; Mishra and Shyam, 2005). There are empirical studies that show positive and significant relationships between the two variables.

3. *Attitudinal approach and well-being.* The attitudinal variable most related to job involvement is job satisfaction. Most scientific studies on the topic find show positive and significant relations between the two variables while only a few find show no relation (Knoop, 1995). This divergence could be motivated by the role adopted by the job involvement variable: cause or consequence. The causal relation between job involvement and job satisfaction has been analysed by many authors (Wyk, Boshoff and Cilliers, 2003; Rabinowitz and Hall, 1977; Lodahl and Kejner, 1965). However, Brown (1996) considers that a cognitive assessment of the possibilities for satisfying potential needs — involvement — precedes the state of satisfaction itself. He also

states that cognitive assessment requires identification with job and an estimation of how important the job is in an individual's lifetime. Accordingly, job satisfaction is a consequence of job involvement (Lawler, 1992). This assertion is in line with the argument of Wegge, Schimdt, Parkes and Dick (2007) who assert that those workers who are more involved in their workplace become more critical in general and reflect the most on how they feel in their workplaces, which enables them to evaluate their degree of job satisfaction.

On the other hand, another attitudinal variable introduced in the current study is motivation. Govender and Parumasur (2010) analyze the relation between employee motivation and job involvement and conclude that there is a significant and positive correlation between these 2 variables.

With regard to the variables related to well-being, the empirical results show that employees that are happier in their workplaces are more productive (Wright et al., 2002). According to Warr (2003), looking after the quality of working life has a positive impact on some employees attitudinal behavior, for example, the identification of an individual with his job in terms of professional performance and self-esteem — emotional involvement. In this line, scientific literature concludes that well-being leads to an immediate improvement in job satisfaction and promotes job involvement, thus resulting in a considerable improvement in performance. In line with this, in the current study some items related to psychology and affecting well-being have been introduced, such as: "I have felt cheerful and in good spirits; I have felt calm and relaxed; I have felt active and vigorous".

Within the framework of psychosocial risk consequences in workplace, many studies attest to the impact of stress on different attitudes such as job involvement, organizational commitment or job satisfaction (Bennet et al., 2011). Singh and Nath (1991) find that employees with high levels of stress are less involved, concluding that work stress is the most important determining factor in job involvement.

Artificial neural networks and organizations. According to Garver (2002) the artificial neural network (ANN) model has the capability to perform better than traditional statistical techniques, and its strength lies in the ability to estimate non-linear and complicated processes without requiring a specific assumption on either its inputs or output variables. ANNs have emerged as a relevant and alternative methodology to some traditional tools for classification of different types of purposes, are data-drive self-adaptive methods, universal functional approximators, non-linear models and are able to estimate the posterior probabilities, which provides the basis for establishing classification rules and performing statistical analysis (Zhang, 2000). The most active application of artificial neural networks is the classification of patterns (classification and prediction) and the approximation of functions (regression) (Cajal et al., 2001).

Over the past few years artificial neural networks have shown satisfactory results in the solution of complex problems, providing a useful methodology for a variety of disciplines: medicine, biology, economy, engineering and psychology (Cajal et al., 2001). In the field of organizations, the use of this methodology is at a very early stage. Specifically, in social psychology these models enable us to predict retention and satisfaction (Yay and Akinci, 2009) or model social behaviors such as the well-known "prisoner's dilemma" (Macy, 1996) or the burnout syndrome (Ladstatter et al., 2010).

Some research studies have dealt with attitudinal variables addressed with artificial neural networks (Wan-I Lee et al., 2008; Aundrain, 2002 and Somer, 1999). Gronholdt and Martesen (2005) analyze customer satisfaction and loyalty in order to classify behavioural patterns based on a number of factors determining such attitudinal variables.

In this research, artificial intelligence is combined with the field of human resources to determine the factors that affect the development of job involvement in its emotional dimension and acquires strategic significance in terms of organizational effectiveness and efficiency. Moreover, from a pragmatic point of view this assertion can lead to the generation of policy options for action in the area of human resources.

Methodology. A classification model is estimated: an artificial neural network called ELM (Extreme Learning Machine) to classify European employees into those who are involved and those who are not. Huang, Zhu and Siew (2004) proposed an Artificial Neural Network (ANN) method known as the Extreme Learning Machine (ELM). For more details on the application of this methodology, the research of Huang, Zhu and Siew (2006) may be consulted.

Data. Data used in this research have been obtained from the 5th European Working Conditions Survey, carried out in 2010 by the European Foundation for the Improvement of Living and Working Conditions. The survey provides insight into the working environment and employment situation throughout the 27 EU Member States as well as in Turkey, Croatia, Norway, Macedonia, Montenegro, Albania and Kosovo. The target population in the study involve those aged 15 years and over (16 and over in Spain, the UK and Norway) who are employed and reside in the country being surveyed. The sample is multi-stage, stratified and random. The total number of interviews in 2010 was 43,816. In the light of the objective of this investigation, we obtained a sub-sample of 1,305 employees, 62.6% of whom reported feeling job involvement, while 37.4% admitted they did not feel involvement. 48.7% were male and 51.3% female. The average age was 41 to 49. Finally, 73.2% had finished secondary education and 26.9% had completed studies at university.

Measurement of dependent variable: The emotional dimension of job involvement is one of the items related to psychological well-being which has been used from the 5th European Working Conditions Survey. The respondents were only asked one question about their individual perception regarding this topic: are you emotionally involved in your work? The response is measured on the Likert scale of 1-5. The employees who felt involved in their jobs were coded as 1 while those who were not were coded as 0.

Measurement of independent variables: The incorporation of new variables into the model has been carried out after a previous selection process based on discriminate analysis. The various explanatory variables are shown in the following 3 categories:

Individual characteristics: age, marital status, level of education and sex.

Job related factors: type of contract, monotonous tasks, complex tasks, repetitive tasks, lifelong learning, variety of skills, participation in decision-making, participation in the selection of colleagues, participation in workflows, flexibility in work methods, expectations for career growth, support of superiors, colleague support, positive relationships at work, sector of activity.

Attitudinal variables and those of well-being: Satisfaction with work conditions and pay level satisfaction, motivation, occupational stress, feeling comfortable in the organization, individual's well-being (experiences or feelings of peace, calm, rest, enthusiasm or activation)

Results (The model and the assessment of network performance). The simplest building block of neural network consists of 3 layers: input, output, and hidden layers and the current neural network contains them (an input layer, a hidden layer, and an output layer). The first layer has 33 neurons (nodes) that represent the explanatory or predictor variables, in our case these are personal, working, attitudinal and well-being factors while the output layer represents the model's classification decisions, in which each decision class (involved and not involved) is represented. The hidden layers in the current model 20 nodes connect the input and output layers indirectly.

According to Collins and Clark (1993) "a disadvantage in the using neural network is that, while networks have shown predictive accuracy in a testing sample, there is no convenient way to interpret cause-effect relationships". The knowledge is contained in its connections and weights, and in the weights are the information about the relationships between independent and dependent variables. Due to the complex connectivity of the neural network, one cannot with any confidence interpret the weight directly. However, according to Masters (1993) there is a broad range of sizeable efficiency measures such as the root mean square of error, confusion matrices or sensitivity and specificity rates. In this research, performance assessment is carried out based on sensitivity, specificity and efficiency rates. The sensitivity of a diagnostic instrument is measured by the percentage of correctly classified individuals who are emotionally involved in their workplace. On the other hand, specificity shows the percentage of correctly classified individuals who are not involved emotionally. Finally, the efficiency shows the total percentage of individuals (who are involved or not) that the model classifies correctly.

Table 1. Accuracy of the model

% Correctly classified	Performance index	ANN (ELM)
General classification	Efficiency	72.39%
Classification class I (Individuals involved)	Sensitivity	90.64%
Classification class II (Individuals not involved)	Specificity	42.27%

One of the objectives of this research is to identify whether an artificial neural network is effective in the classification of individuals emotionally involved in their workplace. Several studies have compared the performance of the traditional methods of classification and the artificial neural networks methods and they have revealed that traditional methods are superior to the ANN methods, whereas the rest concluded the opposite. By focusing on ANN methods, the results of the current model based on the ELM algorithm turn out to be solid in terms of accuracy (Table 1), reaching a high level of efficiency (72.39%), i.e, with the variables introduced to the model, 72.39% of the employees emotionally involved can be identified. A step further through the possibilities offered by ANN methods, Palmer et al. (2000) point out that one of the most important criticisms of the use of ANN is how difficult it is to understand the content of internal representations generated by the neural network. Below is the procedure known as sensitivity analysis as applied to determine the effect

or importance of every predictor variable on the state of emotional involvement in a workplace. The calculation of sensitivity for each attribute or variable is calculated.

This leads to the ranking of sensitivities for each variable:

Table 2. Sensitivity measurement of the predictor variables about attitudinal behaviour of emotional involvement in the workplace

Predictor variable	Sensitivity	Predictor variable	Sensitivity
1. Occupational stress	0,8368	18. Flexibility in work methods	0,3196
2. Participation in decision-making	0,4848	19. Motivation	0,3051
3. Participation in selection of colleagues	0,4794	20. Pay level satisfaction	0,2965
4. Sector of activity	0,4661	21. Satisfaction with work conditions	0,2964
5. Gender	0,4516	22. Day-to-day routines are full of things of interest	0,2930
6. Comfort level within the organization	0,3895	23. The job offers expectations for professional development.	0,2925
7. Type of contract	0,3865	24. Perceives the impression of being responsible for a job well done.	0,2838
8. Feels cheerful and in good spirits (Psychological well-being)	0,3652	25. Social support of colleagues	0,2657
9. Complex and challenging tasks	0,3560	26. Involved in improving the organization and department work processes	0,2635
10. Ongoing learning	0,3555	27. Social support of superiors	0,2592
11. Has the sensation of fulfilling some useful purpose	0,3431	28. Can apply personal ideas and criteria in tasks	0,2337
12. Gets up feeling refreshed and rested (Well-being)	0,3405	29. Monotonous tasks	0,2141
13. Feels energetic (Well-being)	0,3396	30. I am consulted in establishing my work objectives	0,2032
14. Feels calm and relaxed (Well-being)	0,3311	31. The boss encourages me to participate in decision-making.	0,1769
15. Level of education	0,3306	32. The tasks to be done require different skills	0,1513
16. Has friend in the working environment	0,3215	33. The job implies carrying repetitive tasks that do not last more than 10 minutes	0,1091
17. Age	0,3208		

According to Table 2, the variable that has a major influence on emotional involvement is occupational stress ($S = 0.8368$), far more than all other variables. This result is in line with what is found in scientific literature (Singh and Nath, 1991) concerning the influence of occupational stress on certain attitudinal variables such as job involvement.

Then the sensitivity analysis has shown that the variables most related to emotional involvement by far are: participation in decision-making ($S = 0.4848$) and in the selection of colleagues ($S = 0.4794$), sector of activity ($S = 0.4661$), gender ($S = 0.4516$) or feeling comfortable in the organization ($S = 0.3895$). Participation in decision-making acquires a relevant importance in relation with emotional dimension of

job involvement and this confirms the findings of the previous survey in literature. Being stochastic, this methodology is especially suitable for interpreting attributes of extreme sensitivity. So, the variables, which are in the first and the last positions of the ranking, are those that have the greatest statistical significance.

Conclusions. The job involvement of employees in their workplaces is an especially important variable in human resources management at modern organizations. The difficult economic situation currently requires the reappraisal of HRM in order to facilitate the integration of an individual with his/her most immediate working environment — involvement, as a vital element ensuring sustainable and positive organizational outcomes. Employer and employee form part of a single social system — organization — whose articulation requires the efforts of both. In this line and given that emotions plays a fundamental role at the work environment as literature has abundantly shown, this research develops a model that classifies those European employees who are emotionally involved based on personal, labour, attitudinal factors and that of well-being through an artificial neural network trained by the algorithm known as Extreme Learning Machine (ELM). The classification percentage — both global and partial — is adequate. So, 72.39% of the sample was correctly classified through ELM. On the other hand, a step further by focusing through the possibilities that ANN method offers, a sensitivity analysis has been developed which allows knowing the relative importance of each of the independent variables in the model. Also, the sensitivity analysis has made it possible to overcome some difficult issues in interpreting the results generally associated with this methodology.

According to Barling et al. (2004) when people are stressed, they often feel concerned, less vigilant and less efficient in performing tasks. In this case, for example, knowing that the sensitivity of the occupational stress attribute is extremely significant for emotional involvement suggests that the elimination of this variable would considerably reduce the predictive power of the model. This occurs because emotional involvement is very sensitive to stress. It can be assumed that occupational stress, as the result of multiple disadjustments between labour and organizational factors, is becoming the greatest challenge for developing emotional involvement in European employees since this variable affects well-being. Also, through participation in decision-making at work, employees influence on decisions and actions that affect their jobs and an appropriate environment can be created in which employees are more involved. Ultimately, emotional involvement in a workplace is the management and leadership philosophy on how employees are most enabled to provide continuous improvements and the ongoing success of their work organization.

In short, managers could make vital contributions for getting successful organizations if they care the relevant factors which affect on employees' attitudinal and behavioural states such as emotional involvement. The knowledge and assessment of all those variables that influence the emotional involvement in the workplace can be used to help HR managers enhance specific politics and practices in organizations to achieve greater knowledge and improved decision-making.

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