ASSESSMENT OF MOTIVATION BY ENTROPY

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Abstract: Motivation is inseparable from human work. It is also one of the five most important elements of the management process. The ability to determine the level of motivation would therefore be very useful in the work of every manager. This paper is an attempt to quantify motivation and evaluate its size, using the concept of entropy. The main reason to try defining a method of measuring the amount of motivation is to improve the management techniques of companies.

Key words: motivation, human management resources, the hierarchy of needs.

Introduction

A knowledge-based economy is defined as an economy in which the primary component is the management of business processes and skillful management of human resources (Skrzypek, 2008). It is worth recalling at this point that the science that deals with business processes - detecting and describing regularities that govern these processes - is the economy. James Tobin said that if he had to define the concept of an economy, he would say, in a word, "incentives" (Welles). In turn, motivation is one of the most important incentives (Kowalczyk and Mierzejewska, 2011) and also one of the most important issues in personnel management processes of the company.

Humanity grapples with the issue of motivation since the world started. Even today In all business units, despite dynamic technological progress, it is impossible to completely exclude the involvement of employees. To be effective as possible, work made with full commitment and dedication requires adequate motivation (Marescaux et al., 2013). To motivate employees effectively means that even greater harmony between employer's and employee's expectations be achieved. Motivation is therefore a kind of an impulse and a stimulating factor. So far, however, there have not been developed effective tools to quantify the significance of motivation, though it is very essential for every manager.

Economic and psychological dimension of motivation

On the basis of humanistic psychology, The Hierarchy of Needs, often called the pyramid of needs, was proposed by Abraham Maslow. This model is the most commonly invoked concept that explains the workings of the human motivation system. The needs of people help to describe the reality of an acting background for a motivating process. Abraham Maslow said that human needs are met gradually. Man sets higher goals for himself and has greater aspirations only after satisfying their basic desires (Kępińska-Jakubiec and Rafaląt, 2005). Despite this,

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there are no shortcuts. Presented in Scheme 1, the sequence of needs is carried out only in an established order that is, from the needs of lower-order to the higher-order needs. In general, the need for a human is defined as (resulting from the state of absence of) a craving for something necessary to ensure the conditions for the development and functioning of the human being. This desire can relate to material objects, certain emotional states, the results of an action and specific relationships between people. In conclusion, it can be stated that 'need' is a conscious lack of something for a human (Roberts and Lattin, 2006). Moreover, human needs determine lifestyles, value systems, relationships with other people also indirectly affecting the organizational relationships, work atmosphere, an attitude to work and a company. Thus, needs are the components of an organizational culture which is a determinant of a strategic corporate identity.
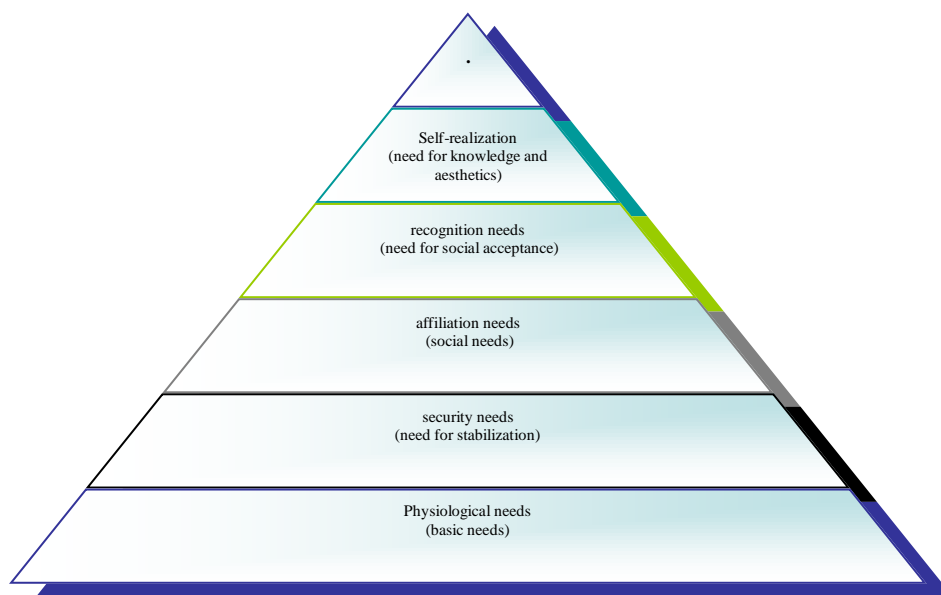

Figure 1. The hierarchy of needs according to A.Maslow

A. Maslow's hierarchy of needs organizes the identified needs into the most basic ones and the less significant needs of the higher level. These are respectively:

- **physiological needs** - the basic survival needs, satisfying hunger, need for sleep, or need for human's biological functioning. The situation is similar in an enterprise because the first-order needs are satisfied when a level of salaries/wages and working conditions are appropriate.
- **security needs** – the needs for the mental and emotional environment. These include such matters as ensuring safety and spending the life which is free from financial worries. Security needs also involve the need for stability, security,

order, justice, or the elimination of hazards. In the organization, these requirements can be met, inter alia, through continuity of employment, the adequate programs of social-security benefits and old age benefits.

- **affiliation needs** - the needs to establish a close contact with people. They include, inter alia, the need for love, friendship, affection, acceptance. Such needs are mostly met by relationships with a family and close friends. The organizational environment can also play an important role in satisfying this kind of needs. Friendships at work or a sense of belonging positively influence the efficiency of human work. These are the elements shaping atmosphere of working.

- **the needs for respect and recognition** - the need to gain recognition from others and the environment. As it comes to the need for respect, it may be undervalued due to the poor assessment of individual's behavior by the environment, hardly satisfactory social status, or insufficient prestige and success. Satisfying these needs is associated with the expectation of appreciating one's actions and commitment. Having transposed the short account on this type of needs into the organization, it can be said that the requirements are met, among others, when employees are praised by the management and because of recognition from a staff.

- **the needs for self-actualization** - they arise from the individual's pursuit of that for which one feels vocation, that is, personal ambition or passion. Relating this to the organization, to fulfil the highest need for self-realization means to satisfy the need to acquire knowledge, to understand the world, and to search for aesthetic experience (Kępińska-Jakubiec and Rafaląt, 2005).

In this context, the most effective motivation can be realized through the development of a work environment where employees are confident that their work and they are respected for their needs are taken under consideration.

It is important to be aware that the emerging needs drive continuous personal improvement since there is no possibility to satisfy the needs fully. When one need is met, another arises. This proves that the nature of an individual is dynamic. Again, there is an analogy of these processes to the life of an organization - stimulation of needs may occur, inter alia, by the probable employees' participation in decision-making or through acquiring new skills (Kowalczyk and Mierzejewska, 2011). The needs are satisfied primarily through an individual action which stems from the fact that human ambitions have no limits. Needs have to be noticed and fulfilled to their fullest. What is more, the organization should monitor them and respond to them where necessary in order to automatically generate enthusiasm for hard work.

The main problem, however, is to determine the correct methods to predict and control employees' behavior patterns which affect the level of realizing the objectives of organizations and employees (Kępińska-Jakubiec and Rafaląt, 2005). The aim is thus to create such a tool, which will allow for an objective and

relatively simple measure of levels of employee's motivation and facilitating the adaptation of form and scope of an effective motivator.

Shannon's information entropy in motivating

Motivation is an abstract quantity which can be considered in terms of the probability of satisfying it. Computer entropy is a measure of ignorance about the inner spatial-energetic structure of matter. It is also a measure of knowledge about the physical system. Expressed in bits, computer entropy tells us how many binary-code symbols should be used on every speck to map all possible microstates of the system. According to Shannon, a message about something that happened, and should have occurred, does not provide even a snippet of information. However, information about independent events should be the sum of the information units. These conditions are fulfilled when the measure of information is a logarithmic function of probability. It is worth noting that Shannon's information entropy is a much more general concept than statistical thermodynamic entropy. The entropy of the information occurs when there are the unknown, which can only be described by a probability distribution. A similar situation takes place when motivation trying to measure and estimation of motivation. The idea of using entropy comes from J.H. Roberts and J. M. Lattin's study (1991) (Roberts and Lattin, 2006). Estimating the level of motivation can be considered as a probability distribution of a Cj need to an Ai employee. Thus, the results of defining the entropy of "Cj" are shown in equation 1 (Roberts and Lattin, 2006):

$$H(x) = \sum_{i=1}^{n} p(i) \log \frac{1}{p(i)} = - \sum_{i=1}^{n} p(i) \log p(i) \qquad (1)$$

where:
p (i) - the probability of satisfying a need
n - the number of all identified needs (generically)
$\phi = 1 / \ln (k)$ is a positive value which ensures that $0 <= E (p1 ... .., pk) <=1$.

It can be seen that the higher value of entropy "E(Cj)" implies less information contained in "Cj", or a weak variation among "pi" of a need among workers, "E(Cj)" can also be used to reflect the relative superiority of one need over the other need. Consequently, some kind of a ranking list of "Cj" needs can be identified.

$$e_j = \frac{E(C_j)}{\sum_{j=1}^{m} E(C_j)'} \quad j = 1, \ldots, m \qquad (2)$$

A set of weights, above = (e₁, ..., below). Formula 2 (Roberts and Lattin, 2006) expresses the priority relation towards the value of employee's needs. A higher value of -ej indicates a higher place in a ranking of needs, for the corresponding need of "Cj".

Measurement of the amount of motivation

Using the method of entropy, we can estimate the priorities of "Cj" needs for "Ai" employees on the basis of the matrix of comparing needs of staff members, which is presented in Table 1, and calculate the probability distribution of "Ci" for each "Ai". Then, the total entropy for each identified "Cj" need may be estimated (Table 1 and Table 2). Ultimately, the procedure should end in determining the ranking of needs with the use of the formula 2 for each team separately.

Study was carried out in an industrial enterprise on a sample of 4 - and 7-seater (two teams of employees).

Table 1. Volume of entropy - Team 1.

The name of the need		Volume of partial entropy for the employee [Aj]							Entropy
		A1	A2	A3	A4	A5	A6	A7	
C1	physiological needs	0,125	0,129	0,125	0,081	0,115	0,136	0,129	0,840
C2	needs for security	0,132	0,126	0,098	0,118	0,104	0,126	0,132	0,836
C3	affiliation needs	0,117	0,131	0,126	0,137	0,114	0,102	0,109	0.836
C4	needs for respect and recognition	0,101	0,133	0,113	0,111	0,123	0,135	0,121	0,837
C5	needs for self-actualization	0,092	0,102	0,142	0,071	0,146	0,127	0,127	0,807

Table 2. Volume of entropy - Team 2.

The name of the need		Volume of partial entropy for the employee [Aj]				Entropy
		A1	A2	A3	A4	
C1	physiological needs	0,157	0,136	0,136	0,159	0,588
C2	needs for security	0,150	0,150	0,150	0,150	0,600
C3	affiliation needs	0,149	0,137	0,140	0,160	0,586
C4	needs for respect and recognition	0,154	0,080	0,091	0,160	0,485
C5	needs for self- actualization	0,152	0,076	0,076	0,160	0,464

From the set of estimated priorities of needs, as Scheme 1 shows, it can be noticed that each team has different priorities of their needs, in other words, every team manifests different characteristics of motivation and gaps in motivation. For the team 2, it is the "C4" need (need for recognition). In the case of the team 1 - the "C2" need (need for security). They both play major roles.

Tables 1 and 2 present estimations of the relative importance of each need identified by the staff and tested by the method of entropy. However, Table 4

presents the results of a comparison of estimates of the ranking of "ej" needs towards the needs of staff in the teams 1 and 2.
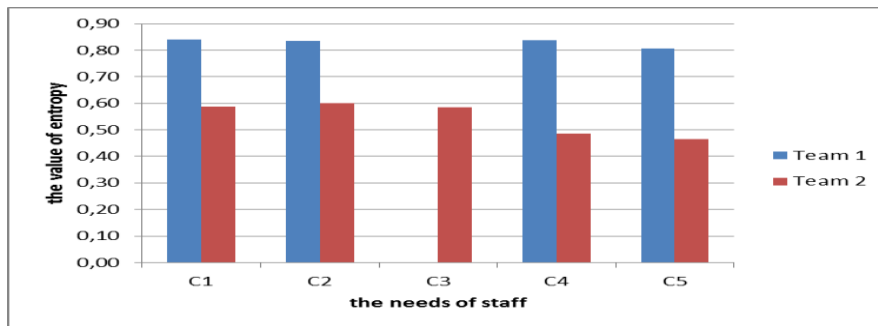

Figure 2. The value of the need

Table 3. The final comparison of the teams in terms of importance of needs

|	Team 1			Team 2	
	The name of the need	ej		The name of the need	ej
C2	physiological needs	0,2210	C4	physiological needs	0,2019
C1	needs for security	0,2156	C3	security needs	0,2017
C3	affiliation needs	0,2149	C2	affiliation needs	0,2016
C4	needs for respect and recognition	0,1778	C1	the needs for respect and recognition	0,1999
C5	needs for self-actualization	0,1707	C5	The needs for self-actualization	0,1949
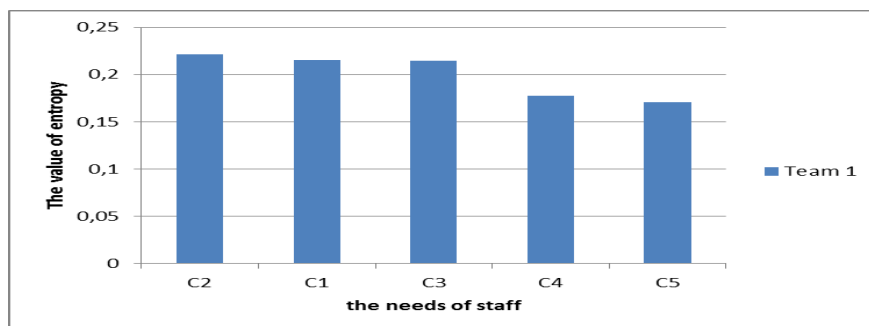
Figure 3. The sequence of needs

These results show that motivation should be approached individually. It is worth noting that the result for the "fulfillment" is the same for both teams. It is not well adapted to the values of these attributes for individual employees, in reference to the abovementioned teams. Briefly, the first and most important task in terms of motivating employees would be reinforcement of needs having the lowest estimated values.
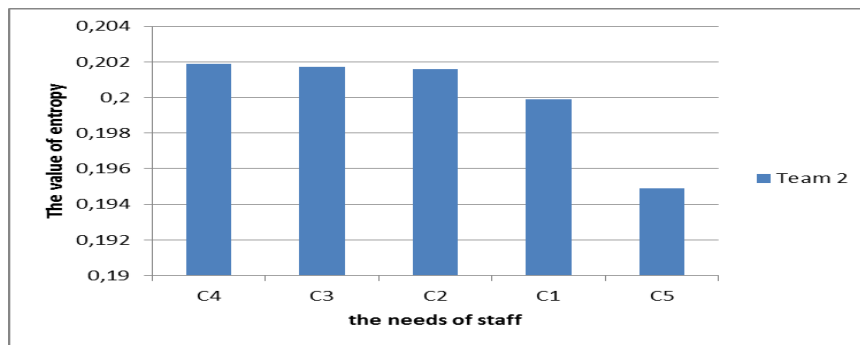
Figure 4. The sequence of needs

Summary

Motivation is an important term commonly used to motivate people to perform work reliably, with dedication and enthusiasm. Motivation is a factor that stimulates workers and gives them energy to overcome fatigue, a lack of interest and willingness to change jobs. The method of entropy of the needs of groups of workers helps in assessing needs. Therefore, the management can reasonably affect the level of motivation among workers. Although the most common forms of motivating employees in enterprises are training and participation in developmental programs, it means for employers that they have to fulfil formal and legal requirements to a large extent. The proposed system of identifying needs and the resultant influence on motivation of employees can also be effective in articulating needs in this area and, thus, a more accurate way to control the level of employees' motivation. It may contribute to selecting methods dedicated to satisfying the specific employees' needs that are adequate for their place in the hierarchy of needs (the Maslow's model). Implementation of the proposed tools will allow employees to match operational needs better within existing resources.

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OCENA MOTYWACJI PRZEZ ENTROPIĘ

Streszczenie: Motywacja jest nierozłącznie powiązana z pracą ludzką. Jest przy tym jednym z pięciu najważniejszych elementów procesu zarządzania. Umiejętność określenia wielkości motywacji byłaby zatem bardzo przydatna w pracy każdego menedżera. Niniejszy artykuł stanowi próbę kwantyfikacji motywacji i ocenę jej wielkości, przy wykorzystaniu pojęcia entropii. Główną przesłanką podjęcia próby zdefiniowania metody pomiaru ilości motywacji jest usprawnienie technik zarządczych przedsiębiorstwa.
Słowa kluczowe: motywacja, zarządzanie zasobami ludzkimi, hierarchia potrzeb.

評估動機由熵

文摘：动机，被密不可分的人权工作。这是管理过程的五个最重要要素之一。因此，能够确定大小的动机，将任何经理的工作中非常有用。这篇文章是大小的动机尝试量化和评估它，使用熵的概念。尝试定义的方法测量所用背后的主要前提是动机的改善公司管理技术
关键字：动机、人力资源管理、需求层次论