SEE-Management by the Force of the Process Functioning System Based on the Output-Input Ratio: the Energy Aspect

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Abstract. The purpose of the study, the results of which are being introduced, is further improvement of the theoretical and practical procedures (methods) for measuring the energy of products and of OIR of the processes of functioning systems based on author's models for efficiency components and their use to appropriate management by processes. The article specifies procedures of the specified type, which were given our previously published works. It was found that the OIR of the process and its effectiveness in the classical sense are equivalent with viewpoint of the characteristic process (as a qualitative component of its efficiency), but the first of these rates (OIR) describes the qualitative component of the efficiency process mainly from the point of view of benefits (profit), and the second states from the standpoint of losses (costs). It is substantiated that the rate of the quantitative component of OIR of the process is the same as the rate of the quantitative component effectiveness in the classical sense, but their qualitative components are distinguished. On the examples of certain processes we showed the practical realization of the methods measuring of OIR for the processes of functioning systems, invented by the authors and its application (together with methods of measuring other author's rates) to manage by the force of the functioning such systems (precisely that is the scientific novelty of the proposed research results). It is emphasized that the proposed methods can be used for the study of complex systems of different types and levels of hierarchy.

Keywords: energy approach; energy of products for the functioning systems processes; force of the process; models of the efficiency components of Burennikova (Polischuk) – Yarmolenko; output-input ratio (OIR) of the process; scale, effectiveness and efficiency of the process; SEE-analysis; SEE-management; total, net and scale products of the process.

1 Introduction

Periodically in the scientific literature there are publications concerning the analysis of systems (in particular physical and economic) based on the so-called energy approach. At the same time effectiveness of the energy conversion is characterized by the output-input ratio (OIR) of the system, which, as proved, is always less than one hundred percent, that is the energy conversion in principle without loss is impossible. Clarifying the concept of “energy” for the physical value of motion, Kolotylo D.M. (1999) (in contrast to the definition of this concept in any textbook or reference book as a generalized measure of the motion matter) emphasizes that it was necessary to say: “no measure” and the characteristic, since the measure of this value is its unit – joule [10]. Just therefore, in our understanding the energy of the system is such a generalized characteristic of a system that determines its quantitatively-qualitative state and determines the transformation of its structure by changing the space-time arrangement of the elements system [27]. It is believed that energy is the driving force of any changes, including the processes of the functioning and development of systems; it is a generalized characteristic of the motion matter.

From the viewpoint of the energy approach the theory and practice of evaluating of the force processes functioning complex systems on the basis of the concept of OIR as a model of effectiveness for the purpose of management these processes are relevant. This necessitates to development of theoretical and practical approaches to the methodology for evaluating the force of the process functioning complex system on the basis of the concept of OIR with the help of author's efficiency rates [27]. This determined the purpose of the paper. The same technique, in our opinion, can be applied as well in relation to the so-called theory of strings, that was considered by Yahelska K. Iu. in [24]. Incorrect understanding by stated authoress of notion OIR leaded her to false conclusions.

2 Review of the Literature

Regarding the problem of research related to the use of energy approaches, it should be noted that scientists studied the energy of systems from different points of view. In particular: Biryukov V. V.

(2000) [1] investigated the time as an economic space for the development of the economic system, considered the generation of so-called economic energy; Veynik A. I. (1991) [23] asserted that all sciences should come to a unified theory; that the notion of energy is universal (it is conditioned), to his idea, by the possibility of application of the energy notion for all without excluding of complex forms of phenomena, and not only to simple substances); Kogan I. Sh. (2009) [9] systematized and classified the definitions and additions to the concept of "energy"; Melnik l. G. (2003) [13] investigated the mechanisms of development on the basis of energy, entropy and information; Podolynskyi S. A. (2000) [17] initiated into the theory of energy; Prangishvili I.V. (2003) [18] studied the problems of managing by complex systems from the point of view of entropy and other system regularities; Rudenko M. D. (2005) [19] formed the ideas about energy of progress; Larush l. (1997) [11], Naiko D. A. & Shevchuk O. F. (2011) [15] considered in essence the energy of systems from the standpoint of problems of the physical economy; K. Yahelska (Yagelskaya Ye. Yu. (2013)) proved the rationality of the allocation of economic energy and, along with other issues of economic energy, also considered some issues, related to the OIR [24]; Kendyuhov A. & Yagelskaya E. (2014) offered and justified expediency of using, in their view, economic force as an indicator of the economic efficiency of the national economy, described its structure and algorithm of measurement, on the basis of the conducted studies calculated the economic force of Ukraine in the course of the period chosen by them [7]; Yahelska K. Iu. (2016) devoted his doctoral dissertation to the theoretical and methodological principles of advancing national economic development, formed, in particular, the methodology of research of the national economy on the basis of the energy approach, developed the concept of an advancing national economic development [25]. It should be noted that Yagelskaya Ye. Yu. (2013), considering in work [24] along with other issues of economic energy and some issues related to the OIR [pp. 103-107], did not provide the algorithm for calculating this coefficient, making mistakes in the calculations and conclusions, believing that it is investigating the OIR, rather than the quantitative component of efficiency; she transferred these errors to her doctoral dissertation [Yahelska K. Iu. (2016), p. 86-88].

By scientific research of the processes based on modeling authors use appropriate to assigned purpose rates, that characterize the obtained results. With regard to the rates of the force of various processes (as the ability of these processes to give a certain result), which is of interest to us at the moment, one can argue that often researchers use the notion of efficiency, considering it to be the concept equivalent to the effect [Borisov A.B. (2007) [2], Liamets V.I. & Teviashev A. D. (2004) [12], Mochernyi, S.V. (2003) [14], Sheremet A.D. & Sayfulin R. S. (1997) [20] and others]. This sometimes leads, in our opinion, to a fuzzy understanding of both efficiency and effectiveness. Some authors use other approaches, distinguishing these concepts, such as the authors of works [Fedulova l.I. (2004) [6], Klymash N.I. (2009) [8], Oleksiuk O.I. (2008) [16], Teslenok I.M., Mykhailova O.V. & Bohachenko O.P. (2012) [21], Tishchenko A.N., Kizim N.A. & Dogadaylo Ya.V. (2003) [22], Zahorna T.O. (2007) [31] and others]. The results of our researches (for more than 20 years) of the force for process functioning systems based on the efficiency category of any process as of such category, which simultaneously is characterized as with quantitative side (in the form of scale product of the process) so and from the qualitative (taking into account the effectiveness of the process) proved that it makes sense to act exactly the same way. Processes were investigated, starting from the labor process (1996) to any process (2012). Studies of various processes in this aspect we continue to this day. The use along with hereby of package of author's rates, proposed by us, as indicators of the process has expanded the innovative approaches to the knowledge of the process functioning system [3, 4, 26, 28, 29, 30 and others].

3 Problem Statement

Regarding the research problems associated with the use of energy approaches, the unsolved part of this problem is betterment of the design and disclosure of the theory and practice of measuring the energy products and output-input ratios (OIR) of subprocesses of the processes functioning systems for the purpose of management these processes. Author's approaches to the application of the efficiency components, mentioned the above, should contribute to solving this part of the problem. The article, which is considering, is a continuation of articles [26, 27], where some results of our studies concerning the measurement of product energies and the measurement of the OIR of the

subprocesses of the processes functioning systems on the basis of the author's rates for efficiency components are presented, but this part of the problem needs of further researches.

The purpose of the study is further improvement of the theoretical and practical methods for measuring the energy products and the output-input ratios (OIR) of the processes functioning systems based on author's models of efficiency components and their use in process management. *The object of research* is the process of managing complex systems of different types and levels of the hierarchy. *The subject* of the research is theoretical and methodological aspects of the effective management by complex systems based on the measurement of energy products and OIR processes of these systems functioning. *The practical significance* of the work is implementation models of efficiency components for measuring in practice the energy of products and the OIR of subprocesses processes of functioning systems based on the author's rates for efficiency components and their application in management by processes.

4 Materials and Methods

The article uses: method of the generalization to find out the essence, role and basic provisions relative to the components of efficiency, measuring of the energy products and measuring of OIR of subprocesses of the processes of functioning of systems, which are analyzed; situational and systematic approaches, methods of analysis and synthesis, induction and deduction for the purpose of investigate the force of the functioning process of the systems which were being studied; computational, comparative and tabular methods for analyzing the influence of factors on the management of the investigated processes; author's models of efficiency components and author's program for calculating relevant rates; SEE-analysis; SEE-management, etc.

We will use our models of efficiency components *of any process* and appropriate rates as indicators of the force of the process. The models are based on the following hypothesis about the consequences of any process. *The consequences* of any process are its products: as benefit (utility); as a cost; the total product in the form of a product as a benefit and a product as a cost; a scale product in the form of a product as a benefit and a part of the product as a cost, proportional to the share product as a benefit in the total product. Rates of the efficiency components we will express using rates of the appropriate products. In the study of processes, as usual, we will use the following equations of change its efficiency:

$$J_R = J_K \cdot J_E = J_K \cdot J_{V/Z} = J_G \cdot J_{1+V/Z}; \quad (1)$$

$$J_R = J_G \cdot J_{1+Z/V} \cdot J_{G/Z} \cdot J_{V/G} = J_G \cdot J_{1+Z/V} \cdot J_{G/Z} \cdot J_{1+Z/G}, \quad (2)$$

where the indices J_R, J_K, J_E and others are indexes of the change of certain rates as the ratios of the corresponding rates to the basic. Rates in the last formula are the following: V - rate of the total product of the process; Z - rate of product of the process as a cost (loss); $G = (V - Z)$ – rate of the product of the process as a benefit; $K = G + Z \cdot G/V$ is rate of scale products of the process; $E = V/Z$ – rate of the effectiveness of the process as the ratio of the rates V and Z; $R = K \cdot E = K \cdot V/Z = G(1 + V/Z)$ is rate of the process efficiency [3, 4, 26, 28, 29, 30 and others].

An information base for calculating of rates for efficiency components in the case, for example, enterprises are their annual financial statements. Rates for calculations should be taken in monetary dimension in actual prices per worker. In other cases certain information base is used with a glance of the fact, that the practical application of the proposed approaches to the study of the particular process on the basis of modeling depends from the specifics of this process and needs special consideration. This is related to the peculiarities of measuring process products [30]. It is known that the energy of the system uniquely depends on the parameters characterizing its state. In any system (for example, social, economic, pedagogical, organizational, environmental, etc.) its elements are combined with various types of ties. Termination or creation of connections requires the consumption of the corresponding energy, the value of which is determined by the type of connections. Some systems require more communication energy, while others require less power [26].

In accordance with our hypothesis of the efficiency reaction existence there is a reaction of system to the appropriate type of communication (social, economic, environmental and organizational, etc.).

The estimation of this reaction, which correlates with the expenditure of energy in relation to the process functioning system, requires of simultaneous consideration of both the quantitative component of a certain rate and its qualitative component. Energy is transmitted to the elements of the system and causes its movement (change of states of the system, its structure, behavior, etc.) [26]. For example, the quantitative component of the rate $K = G + Z \cdot G / V = G \cdot (1 + Z / V)$ of the scale product is rate G, and the qualitative component is rate $(1 + Z / V)$; the quantitative component of the rate $E = V / Z = G / Z \cdot V / G$ of the effectiveness of the process is rate G / Z, and the qualitative component is rate V / G; the rate K is a quantitative component of the rate R of the efficiency of the process, and rate E is a qualitative component. The product of the values of quantitative and qualitative components of a particular rate is equal to the value of this rate. We use stated above for improving and disclosing of a methodology for measuring of the OIR of the process of functioning system on the basis of author's efficiency rates for the purpose of management by this process (together with other rates) on examples of processes related to wages of hired worker of the types of economic activity “agriculture, forestry and fishing” (type of activity 1) and “mining and quarrying” (type of activity 2) of Poland and Ukraine in examined year, and also for systems related to the theory of strings (in the sense of the authoress of work [24]).In the introduction we emphasized that energy is a generalized characteristic of the motion matter. It is known that the energy is produced, transmitted, and its quantity is measured. Any process of a certain type and hierarchical level, developing in space and time, acts as a form of implementation in the spatial and temporal arrangement of energy, specific for this type and level. The consequence (result) of the action of the energy of the process functioning system is its products; therefore it is possible to measure the OIR of the specified process for its products. This can be done, for example, based on author's rates for efficiency components [26, 27].

K. Yahelska, considering the essence and structure of economic energy, naturally stops in sphere of the effectiveness of its transformation on some issues related with OIR [24, pp. 103-107], but, as we noted earlier, does not provide the algorithm for its calculation, making mistakes in the calculations and conclusions, believing that she researches OIR, rather than the quantitative component of efficiency. This authoress, remembered on page 100 of this work the article by Veynik A.I., who argued that phenomena at various quantitative levels of the cosmos (universe) should have certain similar features should obey by certain general laws [23, p. 41]], concluded that, according to the paradigm of this scientist, all the sciences have to come to a unified theory. She also gives an example that in physics theories are united already into the general theory of strings.Yagelskaya Ye. Yu. in article [24, p.101] presents the structure of economic energy as following:

$$E = mV^2, \tag{3}$$

where E is the economic energy, m is the mass of the economic system; and V^2 is acceleration of economic processes (in the latter case K. Yahelska admitted inaccuracy, because V^2 is not acceleration, but the square of speed).

Therefore, considering in the article [26] the practice of measuring the energy of products of the process functioning system on the basis of the rates efficiency components, we clarified that V is the system *speed*, and suggested in the calculations to use formula (4), which is essentially analogous to formula (3):

$$En_D = D \cdot S^2, \tag{4}$$

where En_D, in this case, is the rate of the description energy of a particular product of the process functioning of system: effectiveness, scale (scale product), efficiency, costs, etc.; D is the rate for the characteristic of *the product of the process*, S is rate of the speed of change for this product under the influence of certain factors (in particular, the factor of time, since the products are taken over a specific period of time).Using the fact that the physical content of a partial derivative du / dx (or du / dy) is description of the value of the *speed* for change of a function $U = f(x, y)$ in a point (x, y) when only x (or y) is changed in the direction of the axis Ox (or Oy), we in accordance with (4)

obtained formulas for calculating the energies of products of the process functioning system based on the rates of efficiency components [26, pp. 112-118].

At a later date we emphasized: the values of the rates of the energy of the total product, of the costs (losses) and of the pure product of the process are equal to the value of the rates of these products [26, p. 118]). The latter result is of particular importance, because it indicates that investigating any process with use of the rates of efficiency components is investigating of the process in the energy aspect.

We considered the practical use of derived results of the energy measuring of the efficiency components on the examples of the economic and pedagogical systems [26]. For example, in relation to the economic object of the study we chose the process of capital investment in the protection and rehabilitation of Ukraine's soil, underground and surface waters in 2011-2015, and in relation to the pedagogical object study we chose the process of students teaching. In the paper [27] we proposed to use the formula (5) to calculate output-input ratio η of the process in the form of the ratio of the rate G of the product as the utility of the process to the rate V of the total product of the process (since, as is known, the output-input ratio is defined as the ratio of the useful used energy to the total amount of energy received by the system):

$$\eta = G / V. \tag{5}$$

Using the theory of boundaries, in the stated above paper we received 8 formulas [27, p. 263], which in the extreme cases characterize the fundamental connection between the OIR and the rates of the efficiency components of processes with point of view of their change (increase or decrease).

In the same article (pp. 263-265), we considered the practical use of the obtained results of measuring of the OIR of the process on the examples of economic and educational systems, without considering the system in the aspect of string theory. As an example of the economic object of the study in the same article [27], we chose the process of capital investment in the protection and rehabilitation of Ukraine's soil, underground and surface waters in 2011-2015, and as an example of a non-economic research object, namely, pedagogical are the process of students teaching. The peculiarity of this object consist in the measurement of the valuation rates V, Z, G, K, R in the ball-hours; but not the hryvnias.

5 Experiment and Results

In the proposed article for example in calculating of the OIR of research objects we select initially the types of economic activity “agriculture, forestry and fishing” (type of activity 1) and “mining and quarrying” (type of activity 2) with point of view of processes related to wages for hired workers; then we shall consider the processes, which Yagelskaya Ye. Yu. [24, pp. 105-108] connects with theory of strings. We shall used the results of our work [29], where *on the basis of appropriate modeling approaches to comparative characteristic of force of the employees compensation by types of economic activity at intergovernmental aspect (on the example of designated types of economic activity of Poland and Ukraine) are examined with a glance of the parity of purchasing power (PPP).* It should be noted that the use of some “outdated” data (which relates to 2012) in the following tables 1-5 involves with the need to apply the results, which we obtained in last specified article [29], for the purpose of volume lessening of the article, that is presented, at the expense already obtained by us formerly of results, which can be used to obtaining of new research results. The Table 1 marks the macroeconomic rates, related to the process of production of gross domestic product in Poland and Ukraine during examined year (in actual prices, milliards of national currencies, and also milliards of dollars by PPP), and also value of PPP.

The Table 2 shows macroeconomic rates, related to the types of activity “agriculture, forestry and fishing” (type of activity 1), and “mining and quarrying” (type of activity 2) in Poland and Ukraine during the same year Using the data in Table 2, we found rates of these types of activities in Poland and Ukraine during the examined year, related to compensation of the employees (these rates are marked in a Table of 3).

Based on the Table 3 data, we are calculated the rates of efficiency constituents, related with the process of formation of gross profit, mixed income indicated of activity types of Ukraine in examined

year in comparing with the corresponding rates of this process of Poland with a glance of PPP (it is marked in a Table 4).

Table 1. Macroeconomic rates, related to the process of production of gross domestic product of Poland and Ukraine in examined year****

Rates	Country	
	Poland	Ukraine
1. Gross domestic product: а) (milliards of national currencies)* б) (milliards of dollars)**	 1615.894 872	 1459.1 387
2. PPP: (date of line 1а)/(date of line 1б)***; national currency/dollar	1.853089	3.770284

**** Source: Table data is a copy of the data in the table 1 of article [29, p 68].

Table 2. Macroeconomic rates, related to the types of economic activity 1 and 2 of Poland and Ukraine in examined year***

"Agriculture, forestry and fishing" (type of activity 1)							
Output V_0				**Compensation of the employees** Z_1			
Poland		Ukraine		Poland		Ukraine	
millions of national currencies*	millions of dollars**	millions of national currencies*	millions of dollars**	millions of national currencies*	millions of dollars**	millions of national currencies*	millions of dollars**
132602	71557.275	269983	71608.133	8362	4512.465	26739	7092.039
Gross profit, mixed income G_0						**Number of employees**	
Poland		Ukraine				Poland	Ukraine
millions of national currencies*	millions of dollars**	millions of national currencies*	millions of dollars**			millions of persons*	millions of persons *
46806	25258.366	86330	22897.479			0.1429	0.7418
"Mining and quarrying" (type of activity 2)							
Output V_0				**Compensation of the employees** Z_1			
Poland		Ukraine		Poland		Ukraine	
millions of national currencies*	millions of dollars**	millions of national currencies*	millions of dollars**	millions of national currencies*	millions of dollars**	millions of national currencies*	millions of dollars**
62430	33689.693	153036	40590.046	16162	8721.653	44739	11866.215
Gross profit, mixed income G_0						**Number of employees**	
Poland		Ukraine				Poland	Ukraine
millions of national currencies*	millions of dollars**	millions of national currencies*	millions of dollars**			millions of persons*	millions of persons *
15260	8234.899	54462	14445.066			0.1735	0.4380

*** Source: Table data is a copy of the data in the table 2 of article [29, p. 68].

Data of Table 4 shows that in our case the rating assessments of the OIR of the process are the same as the rating evaluations of effective nesses, but it proves that they are not always the same as rating assessments of scale product and of efficiency process (the latter concerns, for example, a scale product of a type of activity 2 in Table 4, and also follows from Table 2 of the article [27, pp. 263-264].

The rating assessment coincidence of the OIR of the process and rating evaluation of effectiveness (optional coincidence of rating assessments of the OIR the process and, accordingly, rating assessments of scale product and of efficiency) can be explained as follows. Determined the functional relationship between the rates of effectiveness *E*, the scale product *K*, the efficiency of *R* and the rate of output-input ratio η, we have [27, p. 263]:

$$E = V / Z = V /(V - G) = 1/(1 - G / V) = 1/(1 - \eta), \quad (6)$$

$$\eta = G / V = (V - Z) / V = 1 - Z / V = 1 - 1/(V / Z) = 1 - 1/ E, \quad (7)$$

$$K = G + Z \cdot G / V = G + (V - G) \cdot G / V = G + G - G \cdot G / V = G(2 - \eta), \quad (8)$$

$$R = K \cdot E = G(2 - \eta) /(1 - \eta). \quad (9)$$

Since the rate E is the function of only one variable η (formula (6)), and the rates K and R are the functions of two variables G and η (formula (8) and (9) respectively), this explains the stated above. In addition to formulas (6) and (7) it follows that really OIR characterizes the effectiveness of the process (OIR of the process and effectiveness are equivalent with the point of view of the process characteristics. Formulas (8) and (9) indicate that the OIR of the process partly influences on the levels of its scale product and efficiency [27, p. 263].

Data of Table 4 it follows, that the levels of scale product, effectiveness, efficiency, and OIR of the of the economic activity type 1, related to the compensation of the Ukrainian employees, in examined year are lower in comparing with the corresponding rates of Poland, but the levels of effectiveness, efficiency, and OIR of the type 2 of economic activity are higher, and the level of magnitude is lower.

For *SEE*-management by the process, that considers, we will use a methodology based on the components of the efficiency proposed by us in [4]. To this effect we compile a matrix (map) of the *SEE*-management based on the results of the *SEE*-analysis of compensation of the employees as a constituent of costs of the process formation of gross profit, mixed income of types of activity 1 and 2 Ukraine in examined year in comparing with the corresponding rates of this process of Poland (Table 5). The data in this table is based on the data in Table 4 as the difference between the values of indexes of the respective rates.

Table 3. Rates the types of economic activity1 and2 of Poland and Ukraine in examined year, related to compensation of the employees ***

Rates	Poland		Ukraine	
	Type 1	Type 2	Type 1	Type 2
The effectiveness of process of formation of gross profit, mixed income $E = V_0/(V_0 - G_0)$ **	1.5455499	1.3235107	1.4700713	1.5524986
Part of output, which corresponds to the compensation of the employees $V_1 = E \cdot Z_1$ (millions of dollars)**	6974.240	11543.201	10425.803	18422.282
Number of employees(millions of persons)*	0.1429	0.1735	0.7418	0.4380
Compensation of the employees Z_1 (millions of dollars)*	4512.465	8721.653	7092.039	11866.215

*** Source: Table data is a copy of the data in the table 3 of article [29, p. 68]

It should be noted that *SEE*-management is based naturally on *SEE*-analysis. Under the author's *SEE*-analysis of the processes of functioning complex systems, we understand the analysis of the force of these processes with the help of author's models and corresponding rates of the scale product, effectiveness, and the efficiency of the subprocesses of these processes. The letter triplex *SEE* in the title *SEE*-analysis is composed by the authors from the first letters of the lexeme scale, effectiveness, efficiency; the order of letters is explained by the order of calculation of the following rates: scale product is *K*, effectiveness is *E*, efficiency is *R*. Costs on functioning of the process, its net and total products; scale product, effectiveness and efficiency etc. are products of the process [4]. The factors that serve to form the products of this process are called *F*-impulses of the process ($F = R, K, E, \eta, G, 1+ Z/V, G/Z, V/G, V, Z$); these impulses can be both positive and negative [28]. The efficiency components rates of the functioning of systems, the method of using *F*-impulses as indicators of the direction of the consequences of subprocesses of the process of functioning of systems, F-impulses as elements of the author's *SEE*-analysis of the processes of functioning of complex systems are a constituent parts of the mechanism of the *SEE*-management by complex systems [4].

The values of the rates ΔJ_R, ΔJ_K, ΔJ_E, ΔJ_η, ΔJ_G, $\Delta J_{1+Z/V}$, $\Delta J_{G/Z}$, $\Delta J_{V/G}$, ΔJ_V, ΔJ_Z of Table 5 describes the degree of influence of the appropriate factors on the formation of products of the investigated process. These factors of the studied process respectively are: the efficiency of the process (with the rate of *R*); scale of the process (with rate of *K*); effectiveness (with the rate of *E*); net product (with the rate of G); qualitative component of a scale product (with the rate of $(1 + Z/V)$); quantitative component of effectiveness (with the rate of G/Z); qualitative component of effectiveness (with the rate of V/G); total product (with the rate of *V*); costs (with the rate of *Z*).

Matrix of the *SEE*-management on the results of SEE-analysis of the process (Table 5) clearly illustrates the *F* impulses and their impact on the investigated process, *SEE*-reserves and *SEE*-risks, recommended managerial *SEE*-actions [4]. As examples of research objects, we chose the types of economic activity "agriculture, forestry and fishing" (type of activity 1) and "mining and quarrying" (type of activity 2) with point of view of processes related to wages for hired workers. Similarly you can explore other economic processes. In relation to other economic processes, we emphasize that in [3] we considered the sufficient number of performance of the processes of functioning of complex economic systems. They can be used for practical verification for the hypothesis about the possibility of using the author's rates of the components of efficiency for measuring of the OIR of economic processes.

Table 4. Rates description of types of economic activity 1 and 2, related to the of compensation of the employees of Ukraine in examined year, in comparing with the corresponding rates of Poland*

Type 1												
Country	Description of total product of process			Description of product of process as costs			Description of net product of process					
	V		J_V	Z		J_Z	G		J_G			
Poland	48805.04 (1)		1	31577.78 (1)		1	17227.26 (1)		1			
Ukraine	14054.74 (2)		0.2879771	9560.581 (2)		0.3027629	4494.154 (2)		0.2608746			
Country	Description of qualitative component of scale product of process			Description of scale product of process			Description of effectiveness of process					
	$1+Z/V$		$J_{1+Z/V}$	K		J_K	E		J_E			
Poland	1.6470188 (2)		1	28373.62 (1)		1	1.54555 (1)		1			
Ukraine	1.6802391 (1)		1.02017	7551.254 (2)		0.2661364	1.470071 (2)		0.9511637			
Country	Description of efficiency of process		Description of quantitative component of effectiveness		Description of qualitative component of effectiveness			Description of output-input ratio (OIR) of process				
	R	J_R	G/Z	$J_{G/Z}$	V/G		$J_{V/G}$	$\eta = G/V$		J_η		
Poland	43852.85(1)	1	0.545550 (1)	1	2.833012 (2)		1	0.352981 (1		1		
Ukraine	11100.88 (2)	0.2531393	0.470071 (2)	0.8616464	3.127338 (1)		1.103891	0.319761 (2)		0.905887		
Type 2												
Country	Description of total product of process			Description of product of process as costs			Description of net product of process					
	V		J_V	Z		J_Z	G		J_G			
Poland	66531.42 (1)		1	50268.89 (1)		1	16262.53 (1)		1			
Ukraine	42060 (2)		0.6321825	27091.81 (2)		0.5389379	14968.19 (2)		0.9204098			
Country	Description of qualitative component of scale product of process			Description of scale product of process			Description of effectiveness of process					
	$1+Z/V$		$J_{1+Z/V}$	K		J_K	E		J_E			
Poland	1.7555662 (1)		1	28549.94 (1)		1	1.323511 (2)		1			
Ukraine	1.644123 (2)		0.93652	24609.54 (2)		0.8619823	1.552499 (1)		1.173015			
Country	Description of efficiency of process		Description of quantitative component of effectiveness		Description of qualitative component of effectiveness			Description of output-input ratio (OIR) of process				
	R	J_R	G/Z	$J_{G/Z}$	V/G		$J_{V/G}$	$\eta = G/V$		J_η		
Poland	37786.16 (2)	1	0.323511 (2)	1	4.091087 (1)		1	0.244434 (2)		1		
Ukraine	38206.29 (1)	1.011119	0.552499 (1)	1.707821	2.809959 (2)		0.6868491	0.355877 (1)		1.455923		

*Money rates are presented on the average for a year in dollars on one of the employee; indexes are the coefficients of rates of types of activity 1 and 2 of Ukraine to the corresponding rates of Poland; *V* is part of producing, that answers of compensation of the employees; *Z* is compensation of the employees; *G* = (*V* – *Z*) is part of gross profit, that answers of compensation of the employees (rates are expected with a glance PPP).

Source: Table data is derived from the data of Table 4 of work [29, pp. 69-70] by adding columns of values of rates G/Z, V/G, $\eta = G/V$ and J_η, expected by authors. In parentheses in Table 4 we also provided ratings for the respective rates. ($J_K = J_G J_{1+D_Z}$, , $J_E = J_{G/Z} J_{V/G}$, $J_R = J_K J_E$).

Table 5. Matrix (map) SEE-management on the results of SEE-analysis of compensation of the employees as a constituent of costs of the process formation of gross profit, mixed income of types of activity 1 and 2 inUkraine during examined year, in comparing with the corresponding rates of this process of Poland*

Parameters of F-impulses (F = R, K, E, η, G, 1 + Z / V, G / Z, V / G, V, Z) as increment of indices of corresponding process rates*:									
efficiency ΔJ_R	scale product ΔJ_K	effectiveness ΔJ_E	OIR ΔJ_η	net product ΔJ_G	qualitative component of scale product $\Delta J_{1+Z/V}$	quantitative component of effectiveness $\Delta J_{G/Z}$	qualitative component of effectiveness $\Delta J_{V/G}$	total product ΔJ_V	product as costs ΔJ_Z
Type 1									
- 74.69	- 73.39	- 4.88	- 9.41	- 3.91	+ 0.02	- 13.84	+10.39	- 71.20	- 69.72
Influence of F-pulses on the process being investigated									
Negative	negative	negative	negative	negative	positive	negative	positive	negative	Negative
SEE-reserves (+) and SEE-risks (-)									
–	–	–	–	–	+	–	+	-	-
Recommended managerial SEE-actions									
Ensure growth	Ensure growth	Ensure growth	Ensure growth	Ensure growth	Provide the no less level	Ensure growth	Provide the no less level	Ensure growth	Ensure growth
Type 2									
+ 1.11	- 13.80	+ 17.30	+ 45.59	- 7.96	- 0.06	+ 70.78	- 31.32	- 36.78	- 46.11
Influence of F-pulses on the process being investigated									
Positive	negative	Positive	positive	Negati	negative	positive	negative	negative	Negative
Recommended managerial SEE-actions									
+	–	+	+	–	–	+	–	–	–
Provide the no less Level	Ensure growth	Provide the no less level	Provide the no less level	Ensure growth	Ensure growth	Provide the no less level	Ensure growth	Ensure growth	Ensure growth

* Growth of the indexes of efficiency component for the employees compensation process as a constituent of costs for the gross profit formation process, mixed income of types of activity 1 and 2 are considered in comparison: defined rates of the process in Ukraine compared with appropriate rates of this process in Poland in a percent.

Source: calculated by authors.

6 Discussions

We pass on to the application of invented by us of method of calculating of the OIR for processes that are related to the theory of strings, which Yagelskaya Ye. Yu. considered [24].

Cited on S. Yegerev [5], the authoress of the article [24, p. 101] for a minimum unit of economic energy takes a string whose vibrations in accord with the theory of strings, which she mentioned before, set the properties of matter. K. Yahelska notes, that the more frequency of vibration correspond to the more energy accumulated in this vibration, and according to the concept of equivalence for mass and energy ($E = mc^2$), it is greater the mass of the particle, in the role of which manifests itself a string that vibrates [24, p. 101]).

K. Yahelska believes that the mass of economic systems can be represented by a set of masses of factors (elements) that form the economic system, that is, for each element i am inherent its own energy. Thus, economic energy is a defined kind of sub-energy matrix. Each string (S) can take the value of f (force) or l (loss), that is, at a certain time have force or characterized by dissipation, by predominance of losses [24, p. 101]. The effectiveness of the energy conversion is characterized by the OIR of the system, which, as was proved in thermodynamics, is always less than one hundred percent, that is, the conversion of energy without loss is impossible in principle [24, p. 103]. Consequently, each string can take the value of f or l; this means: that each "sub-energy" will depend on the fluctuation of its string, which actually determines the nature of "sub-energy", that is [24, p. 105]:

$$s_i = \frac{f_i}{l_i}. \tag{10}$$

In the future, the authoress singles out several basic elements that, in her view, form the mass of the economic system: the technological reserves, accumulated experience, intellectual capital, goodwill, money supply, resource capital, spiritual and cultural component, political stability. Thus, economic energy can be represented by an array of "sub-energies":

$$E = (e_1 e_2 e_3 \ldots e_n) \cdot V^2. \tag{11}$$

She assigns to each f_i and l_i the values that, in her opinion, most correspond to the present state of the element of the mass of the economic system (the national economy of Ukraine), calling it expert, and proceeding from the formula (11) and operating by velocity *V*, the value of which accepts the maximum – equal to 1. As we noted in the problem statement, K. Yahelska, in this case presented two conditional examples (*we saved the terminology of K. Yahelska*, although this terminology is false concerning OIR): 1) an example of the calculation (determination) of the expert value of the current economic energy of the country for the case if the energy does not exceed 100% (OIR ≤ 100 pct., Table 6 [24, p. 105, Table 1],); 2) an example of calculating the value of the country's economic energy for the case if the energy exceeds 100% (OIR > 100 pct., Table 7 [24, p. 107, Table 2]).

Without going into controversy about the correctness of guiding by K. Yahelska these examples, as those which are related to the theory of strings, we note the following. With our notation we have:

$$E = \frac{V}{Z} = \frac{G}{Z} \cdot \frac{V}{G} = \frac{G}{Z} \cdot \frac{G+Z}{G} = \frac{G}{Z}\left(1 + \frac{Z}{G}\right), \tag{12}$$

$$\eta = \frac{G}{V} = \frac{G}{Z} \cdot \frac{Z}{V} = \frac{G}{Z} \cdot \frac{Z}{Z+G} = \frac{G}{Z} \cdot \frac{1}{1+G/Z}, \tag{13}$$

where the first multiplier in formulas (12), (13) is a quantitative effectiveness component (with a rate *E* or η, respectively) of the subprocesses of the process functioning systems as of a qualitative force component, and the second is a qualitative effectiveness component. Formula (12) characterizes effectiveness mainly with the point of view of the cost of the process, and formula (13) – with the point of view of benefit (utility).

Table 6. Finding the expert value of the current economic energy of the country for the case if the energy does not exceed 100 pct.

Rate	Techno-logical reserves	Accumulated experience	Intellectual capital	Goodwil l	Money supply	Resource capital	Spiritual and cultural component	Political stability
F	0.3	0.4	0.7	0.5	0.4	0.8	0.4	0.3
L	0.7	0.6	0.3	0.5	0.6	0.2	0.6	0.7
E	0.43	0.67	2.33	1.00	0.67	4.00	0.67	0.43

Source: [24, p. 105], Table 1

Table 7. Finding the value of the economic energy of the country for the case if the energy exceeds 100 pct.

Rate	Techno-logical reserves	Accumulated experience	Intellectual capital	Goodwill	Money supply	Resource Capital	Spiritual and cultural component	Political stability
F	0.7	0.8	0.9	0.7	0.8	0.9	0.7	0.7
L	0.3	0.2	0.1	0.3	0.2	0.1	0.3	0.3
E	2.33	4.00	9.00	2.33	4.00	9.00	2.33	2.33

Source: [24, p. 107], Table 2.

In the notation of K. Yahelska formula (12), (13) will have the following form (in our understanding *f* is the rate of utility (benefit), and *l* is the rate of losses (costs)):

$$E = \frac{f+l}{l} = \frac{f}{l} \cdot \frac{f+l}{l} = \frac{f}{l}\left(1+\frac{l}{f}\right), \tag{14}$$

$$\eta = \frac{f}{f+l} = \frac{f}{l} \cdot \frac{l}{f+l} = \frac{f}{l} \cdot \frac{l}{l+f} = \frac{f}{l} \cdot \frac{1}{1+f/l}. \tag{15}$$

It is clear that for each of the mentioned by K. Yahelska main elements that form, in her opinion, the mass of the economic system, corresponds a certain economic process, for which the above formulas can be used. Since in Table 6 and in Table 7 value $f+l=1$, then from formulas (14), (15) it follows that the value $E=1/l$, and the value of output-input ratio $\eta=f$. Consequently, the values of the OIR of the corresponding processes are contained in the first lines of these tables and the values f/l of the quantitative components of effectiveness – in the third.

The specified authoress affirms that in the second case, if e>100 pct (Table 7), this indicates the future transformation of the system, about the coming of crisis [24, p. 105]. According to our calculations, inversely, in the second case value of the OIR is greater than the corresponding value of the OIR in the first case, and therefore the corresponding processes in the second case are more effective in comparison with the processes in the first case (the values of *e* are not the values of the OIR of the systems, but are the values of the quantitative components of effectiveness these systems). Consequently, K. Yahelska mistakenly believes that she is talking about the OIR of the country, and not the quantitative component of effectiveness. She also made false conclusions, indicating the death of the system [24, p. 105], about the future transformation of the system, about the crisis in the second case, etc. [24, p. 108]. In this regard, some other judgments by K Yahelska are incorrect [24, pp. 105-108]. These mistakes and incorrect judgments K. Yahelska transferred to her doctoral dissertation [25, pp. 86-88]. In our previously published works we proves that the rate of the quantitative component of the effectiveness can exceed 100 pct., while the system is stable (then $G>Z$; for example [3, pp. 81, 123, 146, 147, 151, 152, 157; 27, pp. 264, 265]).

7 Conclusions

Methodological approaches to the theory and practice of measuring energy products and of the OIR of subprocesses of the processes of functioning of systems of various types and hierarchical levels require the appropriate algorithms implementation based on modeling. The measuring approaches of the indicated energies and of the OIR of processes based on the use of certain authors' models are being suggested. These models are based on the use of author's rates of efficiency components for subprocesses of processes of functioning of systems. In particular, the following is emphasized: so far as (as we proved earlier) the values of energy rates for general products, products as costs (losses) and pure products (products in the form of profits, benefits) of the subprocesses of the processes functioning systems are equal to the values of rates the mentioned products, the study of certain processes based on the rates of these products automatically means their scientific consideration in the energy aspect. It was found that the OIR of the process and its effectiveness in the classical sense are equivalent with viewpoint of the characteristic process (as a qualitative component of its efficiency), but the first of these rates (OIR) describes the qualitative component of the efficiency process mainly from the point of view of benefits (profit), and the second states from the standpoint of losses (costs). It is distinguished quantitative and qualitative components in the output-input ratio of the process; it allows to characterize the effectiveness of the process (from the point of view OIR) with quantitative aspect as well as and qualitative aspect accordingly. It is substantiated that the rate of the quantitative component of OIR of the process is the same as the rate of the quantitative component effectiveness in the classical sense, but their qualitative components are distinguished On the examples of certain processes we showed the practical realization of the methods measuring of OIR for the processes of functioning systems, invented by the authors and its application (together with methods of measuring other author's rates) to manage by the force of the functioning such systems (precisely that is the scientific novelty of the proposed research results). By the proposed method, we amplify and diversify existing aspects in understanding the factors necessary for the study of concepts and processes based on the energy approach. Further research is planned to be directed to SEE-analysis of power efficient systems.

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