DE GRUYTER OPEN
STUDIA UNIVERSITATIS ECONOMICS SERIES
"Vasile Goldiş" Western University of Arad
DOI: 10.2478/sues-2018-0005

A MODEL TO MEASURE THE PERFORMANCE OF HUMAN RESOURCES IN ORGANISATIONS

Lecturer Magnolia Tilca PhD
"Vasile Goldiş" Western University of Arad
E – mail: tilca.magnolia@uvvg.ro

Elisabeta Mare
SMART APPS & SOLUTIONS", Baia Mare, Romania
E - mail: sales@smartapps.ro

Associate Professor Anca Apatean PhD
Technical University of Cluj – Napoca
E – mail: anca.apatean@gmail.com

(Received: December 2017; Accepted March 2018)

Abstract: The economic crisis, demography, technology, globalization etc. are all factors which will influence the organizational structures and business strategies. A new business strategy will require, among others, that passive Human Resources Management (HRM) change into an active one with a decisive influence upon business. The vision of an active HRM requires that HR information (IT) dedicated systems assist human resources managers in their decision-making. The existing IT systems predominantly manage the salary calculations and, possibly, the employee's professional development, two of the tasks that a human resources manager has to pursue. However, tasks such as assisting, consulting and engaging the human resources in the organization are equally important. IT systems must also develop into these directions. The present paper proposes a solution to measure the performance of human resources by creating an employee performance indicator (EPI). The paper first describes the economic phenomenon involved in the HR performance process, then the mathematical model is formulated, the algorithm is implemented, the solution of the model is analysed from a technical and economic point of view, and finally the decision is made. We use the weighted arithmetic mean to compute the EPI indicator and the correlation formula to establish the degree of relevance between the EPI indicator and the variables involved in the model. An implementation in R is given.
Key Words: ongoing performance management, key performance indicators, multiple linear regression, statistical R environment
J.E.L. CODES: C15, C60, M53

1. Introduction

Nowadays, performant information systems (IS) are able to assist almost the entire activity of an organisation: services, production, sales, customer management, employees, management, decisions and so on. The new business strategies involve the human resources management (HRM) more and more in the decision process. It is about the *performance management* (PM) that consists in "all of the processes that managers use to effectively lead, mange, develop, reward and assess employees" (Garr, 2011).

Most existing HRM information systems are implemented to manage the salary calculations and only few of them manage the employee's professional development. In order to achieve performance management (PM), an *ongoing supporting performance module* was lately implemented in an HRM information system. This module is based on the *continuous performance management* principles and proved to be more efficiency than other performance management software: companies like Microsoft, Google, Adobe, PWC, Cargill and so on, who have recently (2012) adopted this kind of modules, increased their productivity and profits as a result of improving employees' performance.

Management information systems dedicated to ongoing performance management are in a continuous development. The managers are searching to improve the criteria of measuring employees' performance and the software developers are having difficulty finding the concrete formula that measures performance in various situations.

We propose a solution to measure the human resources performance by creating an employee performance indicator (EPI) based on the defined performance criteria of each job.

The first section describes some economic aspects regarding the efficiency of the HR process. In the second section, we give the mathematical solution of this efficiency process. We use the weighted arithmetic mean to compute the EPI indicator and the correlation formula to establish the degree of relevance between the EPI indicator and the variables involved in the model. The solution of the model is analysed from a technical and economic point of view and finally the decision is made. The model is implemented using R statistical environment.

2. Preliminary notes

In modern organisations, "performance management is management" (Garr, 2011). Many organisations treat performance management as a yearly event. Garr proposes an *ongoing performance management framework* which contains all of the activities included in a regular performance management, but the process is continuous. Garr's research shows that companies with an ongoing focus on performance management have better employees, talent and business results: 45% are more likely to have above-average financial performance and 46% are more

DE GRUYTER
OPEN

Studia Universitatis "Vasile Goldis" Arad. Economics Series Vol 28 Issue 1/2018
ISSN: 1584-2339; (online) ISSN: 2285 – 3065
Web: publicatii.uvvg.ro/index.php/studiaeconomia.Pages 57 – 73

likely to be effective at holding costs at the same level or below the level of competitors.

In literary review, the topic of shifting the traditional performance management to continuous one is quite new and it is discussed by researchers and developers at different levels: Garr, analyst of the HR community of Bersin by Deloittes [1], designed a new Performance Management Framework to help HR organisations performance management from an event to a powerful ongoing business activity (Garr, 2011), Gandhi (Gandhi, 2017) underlines, in Chief Learning Officer [2], the importance of adopting an ongoing performance management; experts for IT developers sites, such as Atiim (A-team) [3], propose 10 tips for an Ongoing Performance Management Framework and their advantages (Atiim, 2017); Robertson, manager specialists of Step Two[4], talks about information management that it is not just a technology, but a business processes and practices that underpin the creation and use of information (Robertson, 2005), studies done by researchers from Brandon Hall Group (Brandon Hall Group, 2015) and so on.

Armstrong and Baron define *performance management* (PM) as "a strategic and integrated approach to delivering sustained success to organizations by improving the performance of the people who work in them and by developing the capabilities of teams and individual contributors." (Armstrong & Baron, 1998) *Ongoing performance management* established the term "continuously" to "weekly", "daily".

The most compelling reasons are underlined by Hansen (Hansen, 2017): the annual review is inefficient, managers and employees need more feedback, ongoing feedback actually saves time, feedback is most effective when given in real-time, as it improves engagement and performance.

While performance management is asking "How do we manage the strategy we have put in place*?"* performance measurement asks "How do we track the progress of the strategy we've put in place?" *Performance measurement* "encompasses the assessment of performance and results achieved by individual employees, groups of employees or teams, and entire organizations" (OPM.gov, 2016). Performance measurement uses performance indicators. *Performance Indicators (or Key Performance Indicators KPI)* are the quantifiable masses, both financial and non-financial, of the performance of those tasks, operations or processes which are essential for business.

Tracked continuously and together with strategic objectives of the organisation, *HR performance indicators* improve ongoing performance management. HR performance indicators generally measure employee engagement, performance ratings, retention/turnover, high potential employees (HIPO) [5], employees development plans, readiness for job, internal hire age, diversity of workforce, level of competence and so on. Some HR performance indicators are quantifiable, while others are qualitative indicators. A glossary of employee performance indicators divided into key subject areas can be studied at the ICAEW's page (ICAEW, 2017).

Ongoing performance management in a human resource management context is "the supervision of an employee's work through one-to-one discussions and ongoing feedback from supervisors and regularly scheduled check-ins" (Rouse, 2016). In this regard, *Performance Factors and Behaviour Indicators* are intended to clarify for employees and supervisors what performance or behaviour is expected. There are described seven universal performance factors and four management performance factors (UC Riverside, 2016), with five rating levels for each factor: from exceptional to unsatisfactory performance. If employees clearly understand their assignments, know what level of performance is considered acceptable and receive consistent feedback then employees are successful performers. Technology is especially important in supporting the delivery of the necessary information regarding rated factors.

Technology is driving the evolution of ongoing performance management. The power of developing performant management information systems allowed big companies to implement their management activities regularly instead of sporadically. Thus, ongoing performance management could become part of the human resources' everyday role.

A *human resource information system* (HRIS) [6] is "a suite of software, databases and cloud computing which provide an all-encompassing solution for managing every aspect of a workforce" (Rietsema, 2016). HRISs include modules for classical human resources management like contact information, work progress, pay history, hours worked, benefit tracking and so on. Recently, HRISs were implemented for employee goal tracking which enable employees to set goals collaboratively (align with the organization), see in real time their progress and receive feedback from managers (see Clear Review software).

3. Methodology section

Problem framework

As performance management systems are continuously developing, the present article proposes a model to measure the efficiency of human resources performance which may be implemented in HRIS.

Being known such evaluation *criteria* for employee that *the number of achievements* of the criterion may be determined, in order to evaluate the employee performance correlated with given criterion, we define *the rate of appreciation* as integer number between 0 and 100, less ratings meaning great appreciation, big ratings meaning poor appreciation. Multiplying the number of achievements of each criterion with the rate of appreciation we obtain an *evaluation of each criterion*. Further, by assigning each criterion with *the rate of the importance* in criteria, we can compute the value of importance rate of the evaluation of each criterion. Finally, to determine the performance of an employee, we compute the weighted mean average of rate of the importance in criteria weighted by the evaluation of each criterion.

The employee performance indicator EPI

Definition 1. *Being known n evaluation criteria for employee and the number of achievements of each criterion k_i, $i=1,\dots,n$, the employee performance indicator is defined as weighted mean average*

$$(1) \qquad EPI = \frac{\sum_{i=1}^{n} v_i \cdot p_i}{\sum_{i=1}^{n} p_i}$$

where

- $p_i := k_i \cdot r_i, i = 1,\dots,n$ *is the evaluation of each criterion with*
  - k_i, $i=1,\dots,n$ *denotes the number of achievements of each criterion (an integer positive number) and*
  - r_i, $i=1,\dots,n$ *denotes the rate of appreciation (a number between 0 and 100, less ratings meaning great appreciation, big ratings meaning poor appreciation),*
- $v_i, i = 1,\dots,n$ *is the rate of the importance in criteria (a real positive number between 0 and 10).*

Observation 1. *The formula (1) has sense as denominator is not null. Indeed, the case of all achievements to be zero (* $k_i = 0, \forall i = 1,\dots,n$ *) is excluded, not being a real case.*

Proposition 1. *The employee performance indicator EPI takes real values between 0 and 10.*

Proof:

We have following inequalities:

(2) $0 \le k_i \le \max(k), \forall i = 1,\dots,n, where\, k_i \in \mathrm{N}$

(3) $0 \le r_i \le 100, \forall i = 1,\dots,n, where\, r_i \in \mathrm{N}$

(4) $0 \le v_i \le 10, \forall i = 1,\dots,n, where\, v_i \in \mathbf{R}$

Multiplying inequalities (2) and (3) we have

$0 \le p_i \le 100 \cdot \max(k), \forall i = 1,...,n, where\ p_i := k_i \cdot r_i \in N$.

Thus

(5) $0 \le \sum_{i=1}^{n} p_i \le 100 \cdot n \cdot \max(k)$ or

(6) $0 \le \sum_{i=1}^{n} p_i \cdot v_i \le 1000 \cdot n \cdot \max(k)$.

Dividing (6) and (5) and taking into account *Observation 1*, $0 \le \frac{\sum_{i=1}^{n} p_i \cdot v_i}{\sum_{i=1}^{n} p_i} \le 10$.

Observation 2.

a. *If all the importance rates are equal, then EPI has the value of importance rate.*

b. *If the importance rates have the same value, 10, then EPI has maximum value.*

Proof. Indeed, if $v_1 = ... = v_n = v$ then $EPI = \frac{\sum_{i=1}^{n} v_i p_i}{\sum_{i=1}^{n} p_i} = v$. If the manager establishes the entire importance rate to be 10, or 0, then EPI has the maximum value, 10, respectively the minimum value, 0.

EPI's applicability

To illustrate the applicability of the EPI indicator we take a very simple example. Consider the training program of employees, a mandatory program in any organization. Human resources managers determine when training is necessary and the type of training necessary to improve performance and productivity. Human resource managers are responsible for conducting the training program.

Consider the set of *3* criteria on tracking the training progress of an employee:

- C1: the number of courses employee attended
- C2: the number of graduated courses
- C3: the number of absences from courses

For a certain employee, there are known the number of achievements for each criterion:

- k_1=6 courses attended

Studia Universitatis "Vasile Goldis" Arad. Economics Series Vol 28 Issue 1/2018
ISSN: 1584-2339; (online) ISSN: 2285 – 3065
Web: publicatii.uvvg.ro/index.php/studiaeconomia.Pages 57 – 73

- k_2=4 courses graduated
- k_3=1 absence

The manager previous appreciates each criterion as follows:

- r_1=20
- r_2=30
- r_3=50

The manager previous sets the rate of importance in criteria:

- v_1=8
- v_2=10
- v_3=2.5

Applying formula (1), the employee performance indicator has the value

$$EPI = \frac{8(6\cdot 20)+10(4\cdot 30)+2.5(1\cdot 50)}{6\cdot 20+4\cdot 30+1\cdot 50} = 7.88$$

A score of *7.88* indicates that employee *successfully meets performance expectations.*

Now, considering the case when all the courses are graduated ($k_2=6$) and there is no absence ($k_3=0$), in the same rating values, the EPI is *9.2* that means the employee made an *exceptional performance*.

On the other side, if employee graduated only one course ($k_2=1$) and gets 8 absences ($k_3=8$), EPI is *4.08* that means the *performance needs improvement.*

EPI's interpretation

- *Rating scale*

EPI measures the performance of employee. The feedback is based on the following rating scale: an EPI rated between 10 and 9 means an *exceptional performance*, between 9 and 8 the employee *exceeds performance expectations*, between 8 and 7 the employee *successfully meets performance expectations*, a rate between 7 and 5 means that the *performance needs improvement*, a rate between 5 and 1 denotes an *unsatisfactory performance*.

- *The strength of the association between the EPI indicator and the variables involved in the model*

EPI indicator depends on three sets of variables: number of achievements, rate of appreciation and rate of importance of each criterion. Because each variable contains n values, the total number of independent variables is $n\times 3$. Thus a multiple linear regression is necessary to apply.

Multiple linear regression is a statistical tool that examines how multiple independent variables are related to a dependent variable.

The independent variables are the $n\times 3$ variables involved in the EPI definition:

- the number of achievements: $k_1, k_2, \ldots, k_n$
- the rate of appreciation: $r_1, r_2, \ldots, r_n$
- the rate of importance of each criterion: $v_1, v_2, \ldots, v_n$

Proposition 2. *The equation of linear multiple regression is*

$$\begin{aligned} y_{EPI} &= \beta_0 + \beta_{1,1}\cdot x_{k_1} + \beta_{1,2}\cdot x_{k_2} + \ldots + \beta_{1,n}\cdot x_{k_n} + \\ &+ \beta_{2,1}\cdot x_{r_1} + \beta_{2,2}\cdot x_{r_2} + \ldots + \beta_{2,n}\cdot x_{r_n} + \\ &+ \beta_{3,1}\cdot x_{v_1} + \beta_{3,2}\cdot x_{v_2} + \ldots + \beta_{3,n} + \varepsilon \end{aligned} \quad (7)$$

where

- $x_{k_1}, \ldots, x_{k_n}, x_{r_1}, \ldots, x_{r_n}, x_{v_1}, \ldots, x_{v_n}$ *are the independent variables corresponding to the number of achievements, the rates of appreciation, respectively the rates of the importance;*
- y_{EPI} *is the dependent variable corresponding to EPI;*
- β_0 *is the intercept;*
- $\beta_{i,j}, i = 1, 2, 3, j = 1, \ldots, n$ *are the regression coefficients;*
- ε *is the residual standard deviation.*

Proposition 3. *Knowing data for the independent variables X collected from N subjects and N observations for the dependent variable Y, equation (7) becomes*

$$(7) \quad Y = \beta \cdot X + \varepsilon .$$

The regression coefficients are obtained as $\beta = \left(X^T X\right)^{-1} X^T Y$, (Hervé, 2007)

where

- $Y = \begin{bmatrix} y_1 & y_2 & y_3 & \ldots & y_N \end{bmatrix}^T$
- $\varepsilon = \begin{bmatrix} \varepsilon_1 & \varepsilon_2 & \varepsilon_3 & \ldots & \varepsilon_N \end{bmatrix}^T$

$$X = \begin{bmatrix} 1 & x_{1,k_1} & x_{1,k_2} & \ldots & x_{1,k_n} & x_{1,r_1} & x_{1,r_2} & \ldots & x_{1,r_n} & x_{1,v_1} & x_{1,v_2} & \ldots & x_{1,v_n} \\ 1 & x_{2,k_1} & x_{2,k_2} & \ldots & x_{2,k_n} & x_{2,r_1} & x_{2,r_2} & \ldots & x_{2,r_n} & x_{2,v_1} & x_{2,v_2} & \ldots & x_{2,v_n} \\ \ldots & \ldots \\ 1 & x_{N,k_1} & x_{N,k_2} & \ldots & x_{N,k_n} & x_{N,r_1} & x_{N,r_2} & \ldots & x_{N,r_n} & x_{N,v_1} & x_{N,v_2} & \ldots & x_{N,v_n} \end{bmatrix}$$

- $\beta = \begin{bmatrix} \beta_0 & \beta_{1,1} & \ldots & \beta_{1,n} & \beta_{2,1} & \ldots & \beta_{2,n} & \beta_{3,1} \ldots & \beta_{3,n} \end{bmatrix}^T$.

The β values and regression analyses come from statistical software.

The regression analyses give the correlation coefficient which establishes the degree of relevance between the EPI indicator and the variables involved in the model.

DE GRUYTER OPEN
Studia Universitatis "Vasile Goldis" Arad. Economics Series Vol 28 Issue 1/2018
ISSN: 1584-2339; (online) ISSN: 2285 – 3065
Web: publicatii.uvvg.ro/index.php/studiaeconomia.Pages 57 – 73

Proposition 4. *The correlation coefficient is the percentage of variation in the response EPI that is explained by the regression. The higher the value, the better the regression fits the data. The correlation coefficient is always between 0% and 100%.*

Observation 3. It is known that multiple correlation coefficient always increases (or stays the same) as more independent variables are added to multiple linear regression model, even if the independent variables added are unrelated to the dependent variable (PennState, 2017). However, the multiple linear correlation may be applied to investigate how much EPI is related to the independent variables if there is used a larger sample of data corresponding to more than 40 predicted EPI values (MiniTab Express support, 2016).

4. Findings

In order to compute the value of the employee performance indicator and to determine the intensity of the relation between employee performance indicator and its variables, the statistical `R` software is used. `R` is a free and powerful environment language and software for statistical calculation and graphics which contains linear and non-linear modelling techniques. There is a variety of data types including vectors, matrices, lists and data windows. `R` provides facilities for implementing regressions using functions from `R` packages. In (Tilca & Bojor, 2016), `R` was used to study the outcomes generated by three different types of regression: linear, spline and B-spline regression. Now we use `R` to implement the formula of EPI indicator and to interpret the multiple linear regression and correlation. A complex study about the correlation of the regression variables may be applied starting from the paper (Precup, 2015).

The `R` algorithm is described below.

Input data: n – the number of criteria

The `R` algorithm is described below.

Input data: n – the number of criteria

$c = (c[1] \quad ... \quad c[n])$ – string vector of criteria

$r = (r[1] \quad ... \quad r[n])$ – integer values vector of the rate of appreciation

$v = (v[1] \quad ... \quad v[n])$ – real values vector of the importance rate

$k = (k[1] \quad ... \quad k[n])$ – integer values vector of the number of the achievements

Output data: EPI – the employee performance indicator – real number

Y_{EPI} – the predicted value of EPI – real number

R^2 – square multiple correlation coefficients
Step 1. Inserting the given values
Step 2. Computing the EPI using the weighted mean formula
Step 3. Computing the predicted values EPI using the multiple linear regression
Step 4. Computing the multiple correlation coefficient
Step 5. Displaying the results

The algorithm was implemented in `R`, in `ScriptCode.R` file. The `R`-functions used in algorithm are:

R-function	*Used to*
`cat("…")`	– print the information on-screen;
`readline(prompt=…, "\\,")[[1]]`	– read a line from the terminal;
`as.numeric(.)`	– converting a factor to numeric;
`read.delin("file.txt", header=TRUE, set="," , dec=".")`	– read in delimited files, where data is organized in data matrix with coma-separated elements which has header;
`lm(Y~model,data)`	– create a linear (simple or multiple) regression model given some formula, in the form of Y~X;
`summery(model)`	– summarise the results of model fitting functions;
`coefficients(model)`	– extract model coefficients;
`fitted(model)`	– compute the predicted values of the model;
`runif(n,min=m,max=M)`	– generate random numbers with a uniform distribution;
`floor(n)`	– round a number.

The code from `ScriptCode.R` file is divided in four parts:

- first part implements the employee performance indicator EPI formula,
- second part implements the multiple linear regression model with data imported from text file,
- third part implements the multiple linear regression model with random data,
- forth part gives conclusions.

The `ScriptCode.R` file is called in `R Console`, by tasting `source("ScritCode.R")` (the `ScriptCode.R` file has to be in the current working directory of the `R` process). Data input: the number of criteria, the number of achievements, the rate of appreciation and the rate of importance. The code computes the EPI value for input data. The interpretation of the employee performance regarding the investigated criteria is displayed in the third part Conclusions.

```
EPI<-sum(k*r*v)/sum(k*r)
```

Figure 1. The code of the EPI computation

Source: the author's simulation in R

Data input necessary in the second part of the code need to be organized in a simple `ForRegression.txt` file. The file must contains at least 10 different values of EPI corresponding to 10 employees evaluations. Data are organized in 10×9 matrix with elements comma separated. The data are loaded in `R` using the `read.delim(.)` function and used in regression formula `lm(.)` and `summary(.)`. Thus, the `ScriptCode.R` file returns the regression results: the values of regression coefficients (β vector), the predicted values of EPI (y vector), residual values of the predicted values (ε vector) and the correlation coefficient (multiple R-squared R^2).

```
regression<-lm(Y~k1+k2+k3+r1+r2+r3+v1+v2+v3,data=given_data)
zz<-summary(regression)$r.squared
print(zz)
```

Figure 2. The code of the linear regression predicted values EPI and R-squared coefficient computation using given set of data*

Source: the author's simulation in R

* Here, the `lm(.)` function is applied for 9 independent variables

The third part uses data randomly generated. Considering a sufficiently large number of employees performance evaluations (between *40* and *90*), the code will automatically compute the predicted EPI values and the correlation coefficient R^2 using random data.

```
regression_rand<-lm(Yrand~Xrand)
s_rand<-summary(regression_rand)
print(s_rand)
```

Figure 3. The code of the regression predicted values EPI and R-squared coefficient computation using random data

Source: the author's simulation in R

Forth part of the code displays conclusions about

- the EPI value and the interpretation of the employee performance and

- the degree of relevance between the EPI indicator and the variables involved in the model and the corresponding interpretation.

```
zzz<-summary(regression_rand)$r.squared
cat("Correlation coefficeint for ",N ,"tests and for n=", n, " criteria is =", zzz*100,"%","\n")
c3<-ifelse((zzz>=0.5)&(zzz<0.8),"a good correaltion",
    ifelse((zzz>=0.8),"a verry good correlation",
    ifelse((zz<0.5), "poor correlation")))
print(c3)
```

Figure 4. The code of the R-squared interpretation

Source: the author's simulation in R

5. Conclusions

The evaluation of the employee performance is a constant concern for human resources department. The managers are searching to improve the criteria of measuring employees' performance and the software developers are having difficulty finding the concrete formula that measures performance in various situations.

The solution proposed in this article measures human resources performance. The employee performance indicator (EPI) is based on the defined performance criteria of each job together with numerical values: the number of achievements, the rate of appreciation and the rate of importance for each criterion. The question is how well EPI formula is defined? Are the variables and EPI sufficiently related? An algorithm of multiple linear regression computation is implemented in R in order to indicate the association between dependent variable EPI and independent variables. Applying the ScriptCode.R file we obtain the following conclusions:

```
Conclusions:
1. The employee performance =: 7.87931
[1] "successfully meets performance expectations"
2. The strength between EPI and the variable involved informula:
Correlation coefficeint =  93.39006 %
[1] "a verry good correlation"
3. The correlation ceofficient with random varibles
Correlation coefficeint for  84 tests and for n= 3  criteria is = 68.67723 %
[1] "a good correaltion"
```

Figure 5. The interpretations of the results

Source: the author's simulation in R

1. for the same values as in previous section, the employee performance indicator EPI is *7.88* (the rounded of *7.87931*);
2. for the same values as in previous section, the multiple correlation coefficient between EPI and the variable involved in formula is R-squared

= *0.9339006* a very good correlation; this means that *93.39%* of the variation of the EPI indicator is explained by the variation of the variables (here 9 variables were considered: each of three criterion has three variables);

3. for random generated values of the number of evaluated employees *N*, the number of criteria *n* and the values for variables *k*, *r*, *v*, the multiple correlation coefficient between EPI and the variable involved in formula, R-squared = *0.6867723* a good correlation; this means that *68.67%* of the variation of the EPI indicator is explained by the variation of the variables (here n×3 variables were random generated); the generated number of the experiments (evaluated employees number) is *84* and *3* criteria.

Other elements of the regression analysis are:

- the residuals of the predicted EPI values vary between -*0.7439* and *0.71* – very good predictions;
- the residual standard error *1.696* being small indicates that the regression equation is relevant
- p-value *0.5547>0.05* indicates that the predicted EPI are not statistical significant, but a large number of data will generate more trusted predicted values; thus, for *84* observed data and the *3* criteria, the predicted EPI values are significant because p-value is *6.938e-08*.

Following these results, the variables (the number of achievements, the rate of appreciation and the rate of importance for each criterion) involved in EPI formula are important (significant) in the definition of employee performance indicator. Thus, the EPI indicator, continuously evaluated, may be considered a HR performance indicator in ongoing performance management.

Notes

[1] Bersin by Deloitte delivers research-based people strategies designed to help leaders drive exceptional business performance http://www.bersin.com

[2] Chief Learning Officer – a multimedia publication focused on the importance, benefits and advancements of a properly trained workforce http://www.clomedia.com

[3] A-team – an enterprise goals & continuous performance management platform www.atiim.com

[4] Step two – site for planning and designing solution for the workplace and workforce http://www.steptwo.com.au

[5] High-Potential Employee is an individual with ability, aspiration and engagement to rise to and succeed in more senior, critical positions.

[6] HRIS is known as HRMS - Human Resource Management Systems or HCM - Human Capital Management software

References

1. Adnan, S. & Mohamed, Y., 2014. Performance Evaluation – Methods and Techniques Survey. *International Journal of Computer and Information Technology*, 3(5), pp. 966-979.
2. Armstrong, M. & Baron, A., 1998. *Performance Management Handbook.* London: IPM.
3. Atiim, 2017. *Learn About Goals Setting, OKR framework and Team Performance.* [Online] Available at: https://www.atiim.com/resources/ [Accessed 30 September 2017].
4. Brandon Hall Group, 2015. *The Value of Ongoing Performance Managemen.* [Online] Available at: http://www.iitd.ie/Portals/0/Knowledge%20Centre/The-Value-of-Ongoing-Performance-Manangement.pdf [Accessed 30 September 2017].
5. Gandhi, V., 2017. *Managers, Get Ready for Ongoing Performance Conversations.* [Online] Available at: http://www.clomedia.com/2017/05/31/managers-get-ready-ongoing-performance-conversations/ [Accessed 30 September 2017].
6. Garr, S., 2011. *The Performance Management Framework: Evolving Performance Management to Fit the Modern Workforce*. [Online] Available at: http://www.bersin.com/News/Details.aspx?id=14208 [Accessed 30 September 2017].
7. Hansen, J., 2017. *Why Ongoing Feedback vs. Annual Performance Reviews?.* [Online] Available at: https://www.atiim.com/blog/why-ongoing-feedback-vs-annual-performance-reviews/?utm_campaign=PERFORMANCE%20content%20to%20demo&utm_source=hs_automation&utm_medium=email&utm_content=33636862&_hsenc=p2ANqtz-_DNnMuDLSywt0dwSKqF2mrtWs8jIH1KSuQ-TfOuzMOLAMX7PZ8p [Accessed 5 Octomber 2017].
8. Hearn, S., 2016. *What is Continuous Performance Management?.* [Online] Available at: https://clearreview.com/continuous-performance-management/ [Accessed 5 October 2017].
9. Hervé, A., 2007. Multiple Correlation Coefficient. In: A. Hervé, ed. *Encyclopedia of Measurement and Statistics.* Dallas: Neil Salkind Ed..
10. CAEW, 2017. *Employee key performance indicators (KPI).* [Online] Available at: http://www.icaew.com/technical/business-performance-management-community/data-and-kpis/kpi-library/employee-kpis [Accessed 2 October 2017].
11. MiniTab Express support, 2016. *Interpret the key results for Multiple Regression.* [Online] Available at: http://support.minitab.com/en-us/minitab-express/1/help-and-how-to/modeling-statistics/regression/how-to/multiple-regression/interpret-the-results/key-results/ [Accessed 11 October 2017].
12. O'Brien, J. & Marakas, G., 2007. Management information systems. *A business unit of The McGraw-Hill Companies*, Volume McGraw-Hill/Irwin.

13. OPM.gov, 2016. *Performance Management - Measuring.* [Online] Available at: https://www.opm.gov/policy-data-oversight/performance-management/measuring/# [Accessed 6 October 2017].
14. PennState, 2017. *The Multiple Linear Regression Model.* [Online] Available at: https://onlinecourses.science.psu.edu/stat501/node/311 [Accessed 4 October 2017].
15. Precup, M., 2015. What Drives Private Equity Investiments In R. *Studia Universitatis "Vasile Goldis" Arad Economics Series,* 25(4), pp. 25-42.
16. Prodan, A. & Aruștei, C., 2015. *Managementul resurselor umane.* [Online] Available at: https://portal.feaa.uaic.ro/balti/PublishingImages/Pages/default/Suport_curs_MRU.pdf
17. Rațiu-Suciu, C., Luban, F., Hîncu, D. & Cicoiu, N., 2009. *Modelare economică.* București: Editura ASE.
18. Rietsema, D., 2016. *Understanding HRIS, HRM, HCM.* [Online] Available at: https://www.hrpayrollsystems.net/understanding-hris-hrms-hcm/ [Accessed 2 October 2017].
19. Robertson, J., 2005. *10 principles of effective information management.* [Online] Available at: http://www.steptwo.com.au/papers/kmc_effectiveim/ [Accessed 30 September 2017].
20. Rouse, M., 2016. *Continuous performance management.* [Online] Available at: http://searchhrsoftware.techtarget.com/definition/continuous-performance-management [Accessed 2 October 2017].
21. Tilca, M. & Bojor, M., 2016. Comparative study of different types of regression applied to unemployment in Maramures County of Romania. *Studia Universitatis "Vasile Goldis" Arad. Economics Series ,* 26(3), pp. 44-61.
22. UC Riverside, 2016. *Performance Factors & Behavior Indicators,* California: Human Resources - University of California.
23. wikiHow, 2016. *How to Measure Performance.* [Online] Available at: http://www.wikihow.com/Measure-Performance [Accessed 06.10.2017].
24. Wikipedia, 2016. *Multiple correlation.* [Online] Available at: https://en.wikipedia.org/wiki/Multiple_correlation [Accessed 08.10.2017].

Appendix A

Fig. A.1. Sample of input data

```
> source("ScriptCode.R")
Enter five data:

1. integer number of criteria n= 3
2. text criteria (coma-separated list) c=
nr cursuri,nr cursuri absolvite,nr absente
3. integer values of achievmnts (coma-separated list) k=
6,4,1
4. integer values of appreciation rate (coma-separated list) r=
20,30,50
5. real values of importance rate (coma-separated list) v=
8,10,2.5
```

Source: own results generated by `ScriptCode.R` file

Fig.A.2. Sample of observed data from `ForRegression.txt` file

```
> given_data
     EPI k1 k2 k3   r1   r2   r3   v1   v2   v3
1  7.052  6  4  1 20.0 30.0 50.0 10.0  7.0 0.10
2  7.083  2  2  3 35.0 40.0 70.0 10.0 10.0 5.00
3  2.163  5  2 23 10.0 25.0 35.0  7.0  8.0 1.50
4  3.602 14  6 22 40.0 79.0 95.0 10.0  9.5 0.55
5  4.538  6  2  0 11.0  9.0 30.0  5.0  2.0 7.00
6  5.085 22 13 42  6.4  6.3  4.2  9.0  5.0 2.00
7  8.087  1  1  0 12.0 11.0  4.2 10.0  6.0 2.00
8  2.024  8  0 23 47.0 29.0 78.0  5.0  7.0 1.40
9  7.298 23 14  7 20.0 13.0 50.0  9.5 10.0 3.00
10 5.502  4  7  3 76.0 34.0 65.0  8.0  6.0 1.00
11 4.000  0  2  0 45.0 76.0 43.0  3.0  4.0 2.00
```

Source: own results generated by `ScriptCode.R` file

Fig.A.3. Multiple linear regression analysis using given set of data

```
Residual standard error: 1.696 on 1 degrees of freedom
Multiple R-squared:  0.9339,    Adjusted R-squared:  0.339
F-statistic:  1.57 on 9 and 1 DF,  p-value: 0.5547
```

Source: own results generated by `ScriptCode.R` file

Fig.A.4. Multiple linear regression analysis using random set of data

```
Residual standard error: 0.8241 on 59 degrees of freedom
Multiple R-squared:  0.6868,    Adjusted R-squared:  0.5594
F-statistic:  5.39 on 24 and 59 DF,  p-value: 6.938e-08
```

Source: own results generated by `ScriptCode.R` file

Fig.A.5. Code of the EPI computation with data read from terminal

```
"-----------------------------------------------------------------------------"
#I. EPI FORMULA
readline("Enter five data: \n")
prompt1<-"1. integer number of criteria n= "
n<-as.integer(readline(prompt1), " ")
prompt2<-"2. text criteria (coma-separated list) c= \n"
c<-strsplit(readline(prompt2), "\\,")[[1]]
prompt3<-"3. integer values of achievmnts (coma-separated list) k= \n"
k<-as.numeric(strsplit(readline(prompt3), "\\,")[[1]])
prompt4<-"4. integer values of appreciation rate (coma-separated list) r= \n"
r<-as.integer(strsplit(readline(prompt4), "\\,")[[1]])
prompt5<-"5. real values of importance rate (coma-separated list) v= \n"
v<-as.numeric(strsplit(readline(prompt5), "\\,")[[1]])
EPI<-sum(k*r*v)/sum(k*r)
cat("EPI= ", EPI)
```

Source: own results generated by `ScriptCode.R` file

Fig.A.6. Code for the multiple regression/correlation with imported data

```
"---------------------------------------------------------------------------"
#II. Multiple regression with imported data
given_data<-read.delim("D:/ R/ForRegression.txt",
header = TRUE, sep = ",", dec = ".")
X<-matrix(c(given_data$k1,given_data$k2,given_data$k3,given_data$r1,given_data$r2,
given_data$r3,given_data$v1,given_data$v2,given_data$v3),nrow=length(Y),ncol=9)
regression<-lm(Y~k1+k2+k3+r1+r2+r3+v1+v2+v3,data=given_data)
zz<-summary(regression)$r.squared
print(zz)
print(regression)
rez<-summary(regression)
print(rez)
coefficients(regression)
f<-fitted(regression)
print(f)
```

Source: own results generated by `ScriptCode.R` file

Fig.A.7. Code for the multiple regression/correlation with random data

```
"---------------------------------------------------------------------------"
#III. Multiple regression with random data
nn<-floor(runif(1,min=1,max=15))
N<-floor(runif(1,min=40,max=90))
m<-matrix(ncol=nn*3,nrow=N)
for (i in 1:N) {
kk<-floor(runif(nn,min=0,max=20))
rr<-floor(runif(nn,min=0,max=100))
vv<-runif(nn,min=1,max=10)
m[i,]<-c(kk,rr,vv)}
EPIrand=matrix(1,nrow=N)
for (i in 1:N){
EPIrand[i]<-sum(m[i,1:nn]*m[i,1:nn+nn]*m[i,1:nn+2*nn])/sum(m[i,1:nn]*m[i,1:nn+nn])}
Yrand<-EPIrand
Xrand<-m
regression_rand<-lm(Yrand~Xrand)
s_rand<-summary(regression_rand)
print(s_rand)
```

Source: own results generated by `ScriptCode.R` file