UDC 004.9:614.2
DOI: 10.15587/2312-8372.2020.206567

Mulesa O.,
Snytyuk V.,
Trombola M.,
Ivazkevych V.

INFORMATION AND ANALYTIC EVALUATION OF ACTIVITY INDICATORS OF MEDICAL STAFF IN THE DENTAL CLINIC

Оцінювання показників діяльності об'єкта господарювання будь-якої сфери народного господарства є важливим процесом на всіх етапах існування такого об'єкта. Результати такого оцінювання впливають на планування діяльності закладу на майбутні періоди часу, формування його кадрової політики, проведення реорганізації тощо. При цьому окремо слід розглядати об'єкти сфери послуг, в яких крім показників, що відображають прибуток закладу, важливим є також показники, які характеризують якість наданих закладом послуг. Об'єктом дослідження є процеси інформаційно-аналітичного супроводу прийняття управлінських рішень щодо оцінювання ефективності діяльності кадрового складу стоматологічних клінік. Такий супровід необхідний для аналізу оперативної інформації щодо діяльності медичних працівників та прийняття вчасних і ефективних рішень щодо оптимізації їх діяльності з метою підвищення якості надаваних медичних послуг. Особливої уваги при цьому слід надати питанню визначення критерію ефективності діяльності медичного персоналу.

У роботі були використані методи системного аналізу при дослідженні процесів діяльності працівників стоматологічних клінік при наданні ними медичних послуг. А також методи математичного моделювання – для формалізації задач, які виникають в процесі оцінювання показників діяльності медичних працівників та системний підхід – при аналізі проблеми інформаційно-аналітичного супроводу в процесі оцінювання показників діяльності медичних працівників.

У ході дослідження було запропоновано спосіб підвищення ефективності процесів прийняття управлінських рішень щодо діяльності стоматологічних клінік на основі аналізу показників діяльності їх працівників, шляхом розробки та впровадження релевантного програмного забезпечення. Розроблена інформаційно-аналітична система дозволяє обчислювати та візуалізувати у зручному вигляді співвідношення між такими показниками діяльності медичних працівників, як нормативне та фактичне навантаження. Застосування розробленого програмного продукту дозволить напрацьовувати та приймати вчасні та обґрунтовані управлінські рішення щодо діяльності стоматологічних клінік.

Ключові слова: *інформаційна технологія, інформаційно-аналітичний супровід, оцінювання діяльності медичного персоналу, управління стоматологічною клінікою.*

Received date: 13.02.2020
Accepted date: 16.03.2020
Published date: 30.06.2020

1. Introduction

Evaluation of the activities of an economic entity in any sphere of the national economy is an important process at all stages of the existence of such an entity. The results of this evaluation affect the planning of the institution for future periods of time, the formation of its personnel policy, the reorganization and the like. At the same time, facilities of the service sector should be considered separately, in addition to indicators reflecting the profit of the institution, indicators characterizing the quality of the services provided by the institution are also important. These institutions include medical institutions, in particular dental clinics. When formulating the clinic's activity policy, the founder should be guided by the principle of providing medical services of appropriate quality. One of the criteria affecting the quality evaluation of the services provided is the procedure for the distribution and use of working time of medical workers and compliance with the standards of load on them [1]. In the process of ongoing evaluation of the activities of medical institutions, in particular dental clinics, it becomes necessary to process a large amount of operational data. Therefore, to carry out a comparative analysis and develop managerial decisions, the development and implementation of relevant information technologies in relevant medical institutions is relevant.

This study discusses the problem of designing information technology to evaluate such performance indicators of the staff of medical clinics as the distribution and use of working time.

2. The object of research and its technological audit

The object of research is the processes of informational and analytical support for making managerial decisions to evaluate the effectiveness of the staff of dental clinics. Such support is necessary to analyze operational information about the activities of medical workers and make timely

and effective decisions to optimize their activities in order to improve the quality of medical services.

At the design stage of relevant information technology, it is important to adapt the well-known and develop new models and methods for evaluating the performance of personnel. Based on these models and methods, it is necessary to develop appropriate tools.

3. The aim and objectives of research

The aim of research is to analyze the features that an information-analytical system must meet to evaluate the performance indicators of the personnel of the dental clinic.

To achieve this aim, it is necessary to complete the following objectives:

1. Perform an analysis of the tasks that arise in the process of evaluating the performance of the staff of medical clinics.

2. Systematize the data sets on the basis of which such an evaluation is carried out.

3. To develop relevant software, the use of which will improve the efficiency of decision-making processes on the activities of dental clinics.

4. Research of existing solutions of the problem

A lot of scientific research is devoted to the problem of evaluating the performance of medical institutions, including dental clinics. So, in [2] it is noted that in order to improve the quality of dental services in each medical institution, a commission should be functioning on the examination of the quality of medical care. Management decisions should be made on the basis of approved standards, among which an important place is occupied by medical and economic. Works [3, 4] are devoted to the definition of criteria for quality evaluation of activities of service enterprises (medical institutions) using dental clinics as an example. Researchers note that an important indicator affecting the formation of ratings of dental clinics is staffing and workload of staff, their level of qualification [3]. The indicators, according to this criterion, make it possible to take into account the positive and negative deviations of the available number of doctors and staff per job, their actual workload and qualifications from regulatory data in the general evaluation of the institution.

The work [5] contains a study of the impact of the implementation of information systems in the activities of medical professionals. The authors note that such systems are most effective for managers. That is, the greatest attention in their development should be given to tools for data analysis. Research [6] is devoted to the problem of evaluating the level of perception and use of information technology by dental clinic employees. Based on the results of the surveys, it can be concluded that software products focused on the exchange of information within a medical institution have a positive perception.

An analysis of relevant scientific research has shown that a number of scientific developments are devoted to the tasks of developing and implementing information technology in the provision of dental services. In [7], criteria are given that an information system must meet to manage the data of electronic medical records of patients. Among the main data that should be processed by the relevant information systems, data on the management of receptions, treatment progress, other meetings and the like. Works [8, 9] describe the experience in the development and implementation of electronic medical records systems in the work of dental clinics. In these works, it is noted that an important stage in the design of appropriate technologies is the stage of data collection and organization. It is noted that for the success of a software product, it must be convenient to use. In [10], the rationale for the introduction of information technology in the operation of dental clinics is given. Software products described in these scientific publications, focused only on the collection of medical information, the organization of free access for medical workers to patient data and the like.

The analysis of scientific works showed that the problem of implementing information technology in the field of medical management is promising. Most software products have only a data organization function. The task of information and analytical support of the processes for evaluating the performance of medical personnel remains open.

Works [11, 12] are devoted to the problem of evaluating the personnel potential of a medical institution. It is noted here that personnel potential should be understood as the maximum number of services that can be provided by employees of an institution within working hours while maintaining the quality of these services. Models and methods of such an evaluation are given in [13, 14]. Here, a methodology is proposed for evaluating the activities of employees of an institution, based on a timing approach. The next stage of the study should be the development of tools for information and analytical support for the adoption of managerial decisions on the organization of activities, including dental clinics.

5. Methods of research

In the course of the study were used:

– methods of system analysis in the study of the processes of dental clinic workers in the provision of medical services;

– methods of mathematical modeling to formalize the problems that arise in the process of evaluating the performance of medical workers;

– systematic approach to the analysis of the problem of information and analytical support in the process of evaluating the performance of medical workers.

6. Research results

During the study, an information-analytical system for evaluating the performance of dental clinics was designed. As a basis, in the design process, the methodology for evaluating the human resources potential of healthcare institutions, taken in [9–11], was taken. According to this methodology, the personnel potential of a medical institution understands the maximum number of services that can be provided by employees of the institution within their working time while maintaining the quality of such services. The formal mechanism for maintaining the quality of services in this case is to prevent a reduction in their duration.

The basis of the information-analytical system is data sets on the activities of medical workers [12]. These include:

– information about the employees of the institution: profession, position, list of competencies, the number of working hours per day (Tables 1, 2);

ISSN 2664-9969

– information about services and norms of their duration (Table 3);
– operational information about the services that were provided by the employees of the institution.

Table 1

Fragment of the table of information about employees

Employee number	Specialty	Position	Number of working hours per day
1	dentist therapist	dentist	5
2	dentist surgeon	dentist	8
3	dentist surgeon	head physician	6
4	dentist orthodontist	dentist	6
5	nursing staff	dental assistant	8
…	…	…	…

Table 2

Fragment of the table of competencies of employees

Employee number	Services that an employee can provide
1	Treatment (canal treatment, pulpitis treatment)
2	Tooth extraction, implantation
3	Tooth extraction
4	Bite correction, braces, mouth guards, orthodontic appliances
…	…

Table 3

Fragment of the table with data on services provided by employees of the institution

Category	Name	Minimal duration
Dentistry	Treatment (canal treatment, pulpitis treatment)	from 45 min
Orthopedic dentistry	Aesthetic restoration, fingerprinting, veneers, shape and color correction	from 1 h.
Surgical dentistry	Tooth extraction, osteoplasty, implantation, plasmolifting	from 1 h.
…	….	…

To configure additional system parameters, let's use the results of expert surveys on the loss of working time, standards for the duration of services, etc. [9].

The analytical core of the developed system is formed by models and methods for evaluating the personnel potential of a healthcare institution [9, 10, 12]:

1. A model for evaluating the volume of services that can be provided by employees of an institution for a specified period of time [9].

Let a set of employees of a medical institution be given, which denote by $W=\{W_1,W_2,...,W_n\}$. Let each employee $(i=\overline{1,n})$ be characterized by the following two indicators: h_i – professional group; η_i – rate size.

To calculate the normative workload of an employee for a working month, let's define a function $f(h,\eta)$ that will depend on two parameters: the professional group of the employee and the rate size:

$$f(h,\eta)\to R^+. \tag{1}$$

Let's denote the standard load of the employee W_i for an elementary time interval t through r_{it}, which let's calculate in credits – the smallest arbitrary units of time. Then:

$$r_{it}=\lambda(t)\cdot f(h_i,\eta_i),\ i=\overline{1,n}, \tag{2}$$

where $\lambda(t)$ shows how many working months (what part of the working month) the time interval t takes.

2. The method of evaluating the existing load on the employee of the institution [9].

Let a set of services $S=\{S_1,S_2,...,S_m\}$ be given, each of which is assigned a value s_j $(j=\overline{1,m})$ – the number of credits necessary for its implementation. Let's divide all services into two groups. The first group – services, the volume of which depends on the number of customers. The second group – services, the volume of which does not depend on the number of customers.

Let a matrix of the distribution of services between employees be given:

$$MR=(\alpha_{ij}),\ i=\overline{1,n},\ j=\overline{1,m},$$

moreover

$$\alpha_{ij}\ge 0,\quad \forall j\in\{1,2,...,m\}$$

and

$$\forall i\in\{1,2,...,n\},\quad \sum_{i=1}^{n}\alpha_{ij}=1,\quad \forall j\in\{1,2,...,m\},$$

where α_{ij} – part of the j-th service that the i-th employee performs.

Let's define a function $\varphi_j(t)$ that allows to calculate the volume of services S_j for a period of time t. Then, the volume of credits that the employee worked W_i $(i=\overline{1,n})$ for a given time t interval can be calculated by the formula:

$$q_{it}=\sum_{j=1}^{m}\alpha_{ij}\varphi_j(t)s_j. \tag{3}$$

Analysis of the activities of employees of a medical institution is a comparison of regulatory and actually spent credits. Thus, the functional diagram of the information-analytical system is as in Fig. 1.

Examples of the system configured for the virtual dental clinic are given in Table 4 and in Fig. 2, 3.

According to the results of calculations (Table 4, Fig. 3) it is possible to analyze the distribution of costs of working time of workers for different services. The result of comparing the actual and normative workloads of workers (Table 4, Fig. 2) can be the development and adoption of managerial decisions to expand the staff of employees, their retraining, the expansion of the number of services provided by clinic employees and the like.

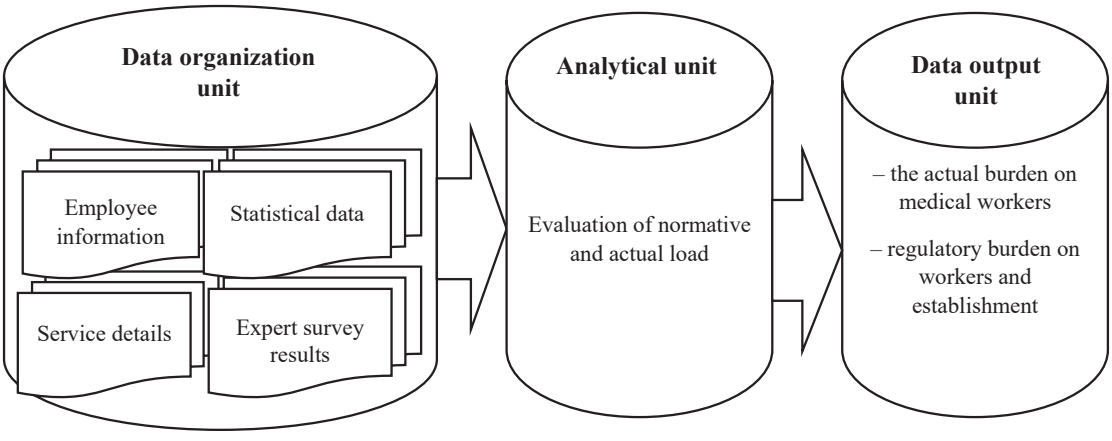

Fig. 1. Functional diagram of the information-analytical system

Table 4

The results of the calculation of employee performance indicators of dental clinic

Employee number	Standard amount of credits	Actual credits	Distribution of credits by services					
			Canal treatment	Pulpitis treatment	Orthodontic dentistry	Tooth extraction	Implantation	Consultations
1	1950	2100	800	1250	0	0	0	50
2	3960	3310	0	0	0	240	3000	70
3	1860	2275	0	0	0	0	2040	235
4	2940	2960	0	0	2460	0	0	500
5	4260	5040	0	0	0	0	5040	0

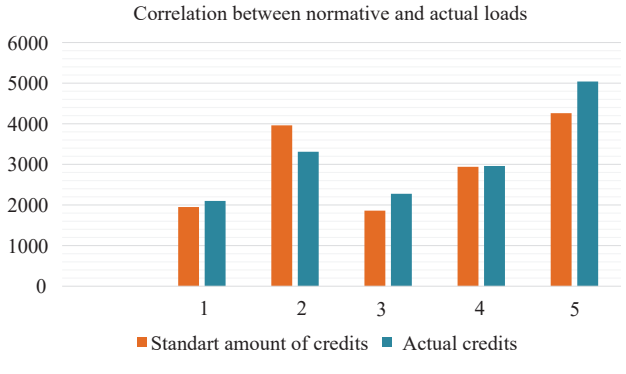

Fig. 2. Comparative analysis of the results

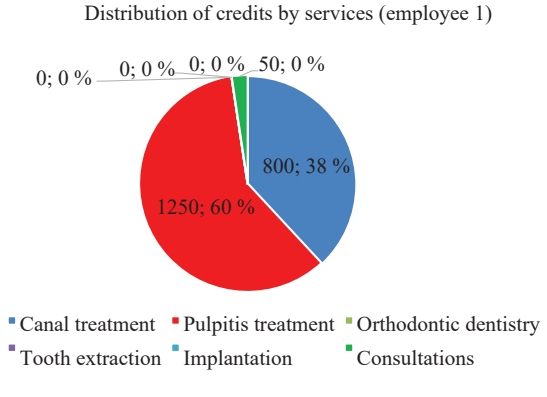

Fig. 3. The mode of analysis of the activities of an individual employee

7. SWOT analysis of research results

Strengths. In the course of the study, a method is proposed to increase the efficiency of managerial decision-making processes for the activities of dental clinics based on an analysis of the performance indicators of their employees by developing and implementing relevant software.

An information-analytical system has been developed that allows to calculate and visualize in a convenient form the ratio between such indicators of medical workers as normative and actual load.

Weaknesses. When applying the developed tool, it is necessary to take into account that all the work performed by employees of the institution is related to the service sector, that is, their intensity and duration can vary through certain subjective circumstances.

Opportunities. Based on the data obtained during the information-analytical evaluation of the activities of dental clinic workers, it is possible to develop and make timely, effective and informed management decisions on the activities of a medical institution.

Threats. To increase the accuracy of the obtained numerical estimates, a preliminary analysis of the types of work performed by employees of the institution, including those not related to the provision of medical services, is necessary. It is also important to evaluate the loss of working time on business trips, rehabilitation and the like. Based on this preliminary analysis, it is necessary to amend the indicators of the normative workload of workers.

ISSN 2664-9969

8. Conclusions

1. The analysis of the tasks that arise in the process of evaluating the performance of the staff of medical clinics. Among the main tasks that need to be solved is the task of evaluating the regulatory burden on the employee and the institution as a whole and the task of evaluating the actual burden on workers.

2. Data sets are systematized on the basis of which such an evaluation is carried out. The basis for the performance evaluation of health workers are:

– data sets on the profession, competence and working hours of employees of the institution;

– information about the services that the institution as a whole can provide, their standard duration;

– expert opinions on the loss of working time, effective working time, etc.;

– statistical data on the services provided by the clinic staff for a specified period of time.

3. An information-analytical system has been developed for calculating estimates of the normative and actual load of clinic workers. The results of the developed software product can be effectively used by managers in the process of making decisions on the organization of work of the corresponding medical institution.

References

1. Myronyuk, I. S., Pereginets, I. B. (2015). Chronometry results for hiv counceling and testing uponan initiative of medical officer in practice of a family physician. *Achievements of clinical and experimental medicine, 20 (1),* 73–75.
2. Kryachko, A. G., Romanenko, I. G. (2010). The ways of the improvement of qualitative dental aid. *Bulletin of Dentistry, 4,* 85–94.
3. Primak, T., Hnatiuk, L., Kirichishin, I., Kostyuk, M. (2013). Marketing in the process of rating companies them are working in servises sektor. The rating of dental clinics of Kiyv. *Economic Bulletin of the National Technical University of Ukraine Kyiv Polytechnic Institute, 10,* 404–412.
4. Hnatiuk, L. M. (2012). *Marketynhove doslidzhennia ochikuvan naselennia ta likariv vid reformy medychnoihaluzi. Marketynh v Ukraini.* Kyiv: VHO «Ukrainska asotsiatsiia marketynhu», 196.
5. Wachter, R. M., Howell, M. D. (2018). Resolving the Productivity Paradox of Health Information Technology. *JAMA, 320 (1),* 25–26. doi: http://doi.org/10.1001/jama.2018.5605
6. Prasad, B., Mahato, T. K., Rajendran, G., John, J. R. (2017). Health Information Technology (HIT): A Hit or Miss in Private Dental Practice in Chennai, Tamil Nadu, India – A Cross Sectional Survey. *Pesquisa Brasileira Em Odontopediatria e Clínica Integrada, 17 (1),* 1–8. doi: http://doi.org/10.4034/pboci.2017.171.39
7. Acharya, A., Shimpi, N., Mahnke, A., Mathias, R., Ye, Z. (2017). Medical care providers' perspectives on dental information needs in electronic health records. *The Journal of the American Dental Association, 148 (5),* 328–337. doi: http://doi.org/10.1016/j.adaj.2017.01.026
8. Santoso, B. T., Gejir, N., Fatmasari, D. (2017). Information System Monitoring Model Implemented in School Health Dental Unit. *ARC Journal of Dental Science, 2 (4),* 8–11. doi: http://doi.org/10.20431/2456-0030.0204003
9. Sidek, Y. H., Martins, J. T. (2017). Perceived critical success factors of electronic health record system implementation in a dental clinic context: An organisational management perspective. *International Journal of Medical Informatics, 107,* 88–100. doi: http://doi.org/10.1016/j.ijmedinf.2017.08.007
10. Chauhan, Z., Samarah, M., Unertl, K., Jones, M. (2018). Adoption of Electronic Dental Records: Examining the Influence of Practice Characteristics on Adoption in One State. *Applied Clinical Informatics, 9 (3),* 635–645. doi: http://doi.org/10.1055/s-0038-1667331
11. Myroniuk, I. S., Mulesa, O. Yu., Nikolko, M. V. (2016). Instrument otsinky kadrovoho potentsialu saitiv ART yak zasib planuvannia rozshyrennia okhoplennia medychnymy posluhamy predstavnykiv tsilovykh hrup naselennia. *Za kozhne zhyttia razom: pryskorennia do mety 90-90-90. Profilaktychna medytsyna, 3-4 (27),* 104–105. Available at: https://dspace.uzhnu.edu.ua/jspui/handle/lib/15905
12. Mulesa, O., Snytyuk, V., Nazarov, V. (2019). Research of information-analytical aspects for optimization of the health care institutions. *Technology Audit and Production Reserves, 6 (2 (50)),* 10–13. doi: http://doi.org/10.15587/2312-8372.2019.191913
13. Mulesa, O., Geche, F., Nazarov, V., Trombola, M. (2019). Development of models and algorithms for estimating the potential of personnel at health care institutions. *Eastern-European Journal of Enterprise Technologies, 4 (2 (100)),* 52–59. doi: http://doi.org/10.15587/1729-4061.2019.174561
14. Mulesa, O., Geche, F., Batyuk, A., Myronyuk, I. (2018). Using A Systematic Approach in the Process of the Assessment Problem Analysis of the Staff Capacity Within the Health Care Institution. *2018 IEEE 13th International Scientific and Technical Conference on Computer Sciences and Information Technologies (CSIT), 1,* 177–180. doi: http://doi.org/10.1109/stc-csit.2018.8526749

Mulesa Oksana, *PhD, Associate Professor, Department of Cybernetics and Applied Mathematics, State Higher Educational Institution «Uzhgorod National University», Ukraine, ORCID: http://orcid.org/0000-0002-6117-5846, e-mail: mulesa.oksana@gmail.com*

Snytyuk Vitaliy, *Doctor of Technical Sciences, Professor, Dean of Faculty of Information Technology, Taras Shevchenko National University of Kyiv, Ukraine, ORCID: http://orcid.org/0000-0002-9954-8767, e-mail: snytyuk@gmail.com*

Trombola Mykhailo, *Postgraduate Student, Department of Cybernetics and Applied Mathematics, State Higher Educational Institution «Uzhgorod National University», Ukraine, ORCID: http://orcid.org/0000-0002-5044-799X, e-mail: mishatrombola@gmail.com*

Ivazkevych Viktoriia, *Lecturer, Department of Pediatric Dentistry, State Higher Educational Institution «Uzhgorod National University», Ukraine, ORCID: http://orcid.org/0000-0002-0080-467X, e-mail: vikiblonda@gmail.com*