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IMPROVING HEALTHCARE INSTITUTIONS EFFICIENCY AFTER COVID-19 BY APPLICATION OF KEY PERFORMANCE INDICATORS: A CASE OF SERBIA

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Abstract: The purpose of this paper is to analyze the efficiency of healthcare services in healthcare institutions in the years before and after the pandemic COVID-19 by application of Key Performance Indicators (KPIs). The aim of this paper is to show the possibilities of improving the efficiency of healthcare services in healthcare institutions by applying KPIs. For the comparative analysis, 12 KPIs divided into six groups are defined, monitored, measured and compared, as a tool applied to the analysis of specific data of one of the largest healthcare institutions in the Republic of Serbia, Clinical Hospital Center "Dr Dragiša Mišović - Dedinje" in Belgrade, from six-month reports for the years before and after the pandemic COVID-19, i.e. 2019 and 2022. The results observed from the comparative analysis indicate that in the post-COVID year, at the institution level, 11 applied KPIs decreased in value, and only one KPI had an imperceptible value increase. The results of the conducted analysis can be applied to increase the efficiency of healthcare services in healthcare institutions. Recommendations for improving the efficiency of healthcare services are: Reduction of waiting lists for specialist examinations and operations created during the pandemic COVID-19; Online consultations by application of digital technologies; Coordination of activities, employees and all types of examinations; Alignment of available material and non-material resources and providing timely interventions; Capacity adjustment of the specialist examinations to the number of post-COVID patients; Additional training of employees, especially those who started working in the COVID regime.

Keywords: healthcare institutions, efficiency, improving, key performance indicators, comparative analysis, COVID-19.

INTRODUCTION

In late January 2020, the COVID-19 pandemic gained enormous global attention [1]. Since that moment, healthcare has undergone major changes and consequences and the main risks that healthcare employees confront are highlighted [2]. The appearance, but also the unexpected retention of the virus, further impacted the attempt to destabilize the already exhausted health systems.

The social representations of health influence the demands and expectations of health, the policymakers, the healthcare systems and many other key aspects of health [3]. The complex characteristics of healthcare services, such as intangibility, heterogeneity and variability, have a significant impact on defining and measuring the quality of healthcare services.

Quality of care received presents a valuable factor that improves health disparities [4]. That quality depends to a large extent on the number, expertise and commitment of the health employees, as well as the process of providing the services and the interaction between the patients and the service provider. Dimensions and characteristics of healthcare services such as consistency, completeness and efficiency are very difficult to measure due to the presence of subjectivity factors. That subjectivity reflects on the concept of 'health literacy' referring to an ability of a person to understand, acquire and use information about health and health services [5]. Differences in service providers, place and time of service provision are complicating factors for evaluating healthcare services.

The current state of healthcare, but also in all other spheres of work and life, is characterized by the transition from the pandemic period to the non-pandemic period, where the most affected sector is the healthcare sector. Given the dynamism and unpredictability of the healthcare sector, the accuracy

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and precision of information are of significant importance to be able to make the necessary changes in healthcare institutions on time and to implement adequate strategies for improvement. Integration of information about healthcare services and all healthcare institutions is needed. This integration can be done with a team of social and health professionals who are engaged with communities and individuals [6].

Health services research focuses on the relationships between demand for care and supply of care, as influenced by the structure and institutions of the healthcare system [7]. To maintain and improve the quality level of healthcare service, it is necessary to monitor and measure performances, performance indicators and KPIs. Performance management strategy represents a scheme that incentivizes employees in the public sector and sought to raise their productivity [8]. The importance of the application of KPIs in the healthcare sector is the monitoring and comparison of work plans with their executions. Based on that conclusions are drawn, how and with which activities are possible to improve the process of management and provision of services in the healthcare sector. The main goal of each healthcare institution is to recognize the factors that will improve patient-centered care [9]. The application of performance management in healthcare is a topic that is still evolving. Authors Mitricevic *et al*. [10] presented the research on the performance and availability of healthcare services in general practice, pediatrics and gynecology and analyzed the influence of health and sociodemographic determinants on preventive healthcare services utilization. The study presented in [8] focuses on three indicators for measuring the waiting targets: the average waiting per hospital, the share of waiting admission to total admission and patient perception of waiting time before admission based on the Overall Patient Experience Score which allows patients to score how they evaluate the length of time. The author Smith in [11] explains the results of the British National Health Service that had an attempt to improve performance by implementing the business models of performance management. The study presented in [12] sets out to assess the practice of performance management in a sample of 15 case studies conducted in healthcare organizations from all around the world. The author Gerrish in [13] has done a meta-analysis on the impact of performance management on performance in public organizations, considering 6 healthcare organizations. Authors Vainieri *et al*. in [14] presented three emerging challenges for performance management systems in healthcare: the inclusion of the population approach, the measurement and consideration of the multi-facet concepts of value and the importance of resilience and sustainability. In [15] an extensive listing of clinical and non-clinical KPIs is presented. Authors Dascalu *et al*. in [16] compared values of monthly clinical activity indicators for the period before and during the COVID-19 pandemic: the number of one-day hospitalizations, the number of continuous hospitalizations, the percentage of emergencies, the number of surgeries, bed turnover and mean value of hospital stay.

This paper presents the application of KPIs in healthcare institutions to improve the efficiency of healthcare services. The focus is on defining an appropriate set of KPIs and presenting the possibility of their application on the concrete example of the Clinical Hospital Center (CHC) "Dr Dragiša Mišović - Dedinje", Belgrade, as one of the largest healthcare institutions in the Republic of Serbia that worked under a special COVID regime throughout the entire period of the pandemic COVID-19. Monitoring, measurement and comparison of KPIs values were done on concrete data of observed CHC for years before COVID (2019) and post-COVID (2022). As the data from the whole year 2022 are still in process, data from six-month reports (from January to June) for both years were used to perform a comparative analysis of the observed results. Based on comparative analysis, the deficiency and deviations are identified, as well as recommendations for improving the efficiency of healthcare services in healthcare institutions by the application of this set of KPIs.

METHODS

To improve the quality of life and health of the population, it is necessary to ensure a high level of quality education for health workers, as well as a high level of quality healthcare services. By monitoring and measuring adequate KPIs of healthcare services and the institutions that provide them, it is possible to determine the differences, but also the roots of the origin of those differences in inequalities in the provision of healthcare services, in different territories, parts of society and age groups. In the following, KPIs related to the provision of healthcare services at healthcare institutions are defined, applied and analyzed. A total of 12 KPIs divided into six groups were defined and presented in Table 1, where the symbol i indicates the organizational unit considered for KPI`s calculation.

The first group of KPIs – Total employee participation. The total number of employees depends

Table 1. KPIs for healthcare services management improvement in the healthcare institution

KPI groups	KPI No.	KPI names	KPI formulas
1. Total employee participation	1	The percentage of employees in relation to the planned number of employees - PEP_i	$PEP_i = NPE_i/TN_i*100$ [%] Where: · NPE_i – Number of permanent employees at CHC level or by category [1]; · TN_i – Total norm at the level of CHC or each category of employee [1].
2. Hospital bed capacity utilization	2	Achieved percentage of hospitalized patients - PHP_i	$PHP_i = NHP_i/PNHP_i*100$ [%] Where: · NHP_i – Number of hospitalized patients at CHC, clinic or hospital level [1]; · $PNHP_i$ – Planned number of hospitalized patients at CHC, clinic or hospital level [1].
	3	Achieved percentage of hospitalization days per patient - PHD_i	$PHD_i = RHD_i/PHD_i*100$ [%] Where: · RHD_i – Number of realized hospitalization days per patient at CHC, clinic or hospital level [1]; · PHD_i – Planned number of hospitalization days per patient at CHC, clinic or hospital level [1].
	4	The achieved average duration of treatment per patient - ADT_i	$ADT_i = DTP_i/PDTP_i$ [day/patient] Where: · DTP_i – Average duration of treatment per patient at CHC, clinic and hospital level [day/patient]; · $PDTP_i$ – Planned average duration of treatment per patient at CHC, clinic and hospital level [day/patient].
	5	Achieved average occupancy of beds - AOB_i	$AOB_i = OBP_i/POBP_i*100$ [%] Where: · OBP_i – Average occupancy of beds per patient at the CHC, clinic or hospital level [1]; · $POBP_i$ – Planned average occupancy of beds per patient at the CHC, clinic or hospital level [1].
3. Percentage of performed specialist examinations	6	Achieved percentage at performed specialist examinations - PSE_i	$PSE_i = NPE_i/PNPE_i*100$ [%] Where: · NPE_i – Number of performed specialist examinations at the CHC, clinic or hospital level within the CHC [1]; · $PNPE_i$ – Planned number of performed specialist examinations at the CHC, clinic or hospital level within the CHC [1].
4. Percentage of performed operations	7	Achieved percentage of operated patients - POP_i	$POP_i = NPO_i/PNPO_i*100$ [%] Where: · NPO_i – Total number of patients operated at the level of CHC, clinic or operating type of hospitals [1]; · $PNPO_i$ – Total planned number of patients operated at the level of CHC, clinic or operating type of hospitals [1].
	8	Achieved percentage of performed operations - PPP_i	$PPP_i = NOP_i/PNOP_i*100$ [%] Where: · NOP_i – Total number of operations performed at the level of CHC, clinic or operating type of hospitals [1]; · $PNOP_i$ – Total planned number of operations at the level of CHC, clinic or operating type of hospitals [1].
5. Percentage of performed laboratory services	9	Achieved percentage of performed laboratory analyses - PLA_i	$PLA_i = NLP_i/PNLP_i*100$ [%] Where: · NLP_i – Total number of laboratory patients at the CHC, clinic or hospital level within the CHC [1]; · $PNLP_i$ – Total planned number of laboratory patients at the CHC, clinic or hospital level within the CHC [1].

KPI groups	KPI No.	KPI names	KPI formulas
5. Percentage of performed laboratory services	10	Achieved percentage of examined samples - PES_i	$PES_i = NES_i/PNES_i*100$ [%] Where: · *NESi* – Total number of examined samples at the CHC, clinic or hospital level within the CHC [1]; · *PNESi* – Total planned number of examined samples at the CHC, clinic or hospital level within the CHC [1].
	11	Achieved percentage of patients as users of laboratory services - PLS_i	$PLS_i = NLA_i/PNLA_i*100$ [%] Where: · *NLA i* – Total number of laboratory analyses performed at the CHC, clinic or hospital level within the CHC [1]; · *PNLAi* – Total planned number of laboratory analyses performed at the CHC, clinic or hospital level within the CHC [1].
6. Percentage of sanitary and expendable material consumption	12	Achieved percentage of sanitary and expendable material consumption – PMC	PMC = SFR/PSFR*100 [%] Where: · *SFR* – Spent financial resources for sanitary and expendable material consumables at CHC level [RSD]; · *PSFR* – Planned financial resources for sanitary and expendable material consumables at CHC level [RSD].

on the prescribed norms defined according to the Official Gazette of the Republic of Serbia [17]. KPI PEPi measures the ratio between the expected number of employees prescribed by the norm and the actual number of employees in the healthcare institution. By observing and monitoring this KPI at lower organizational levels, by employee groups, a better insight is gained into which group of employees impacts the assessment of the fulfillment of the work plan at the level of the entire institution.

The second group of KPIs – Hospital bed capacity utilization. This group of KPIs presents the ratio of the number of hospitalized patients, the number of days of treatment and the number of occupied hospital beds in an observed period. Capacity utilization is observed at the level of each organizational unit and the level of the entire institution CHC. It is calculated through four KPIs: PHPi - Achieved percentage of hospitalized patients, PHDi - Achieved percentage of hospitalization days per patient, ADTi - Achieved average duration of treatment per patient and AOBi - Achieved average occupancy of beds. The total number of hospital beds is defined according to the Official Gazette of the Republic of Serbia [17]. The total number of beds per organizational unit is defined by the institution independently. The number of hospitalized patients is a variable category.

The third group of KPIs - Percentage of performed specialist examinations. KPI PSE can be monitored by organizational units or at the institution level for the observed period. For specialist examinations, there are prescribed procedures and time norms per doctor, on a daily, monthly and annual level, and they are defined by the Official Gazette for each branch of medicine [17].

The fourth group of KPIs – Percentage of performed operations. Operation is understood as any surgical procedure performed in the operating room. Monitoring the total number of operations reflects on monitoring and measuring the number of operated patients and the total number of realized operations. The percentage of performed operations is represented by a set of KPIs: POPi - The achieved percentage of operated patients and PPPi - The achieved percentage of performed operations.

The fifth group of KPIs – Percentage of performed laboratory services. This group of KPIs is applied to calculate the number of patients treated in ambulance and infirmary that uses the services of one of the laboratories within the CHC, for diagnostics and treatments. Laboratories that provide these services include hematological, biochemical, microbiological, pathohistological, hormonal and transfusion diagnostics. It is possible to monitor the number of analyses performed per patient in the ambulance and infirmary, as well as calculate the cost of each patient's treatment based on the planned funds for laboratory material and the number of examined patients. These are the KPIs: PLA - Achieved percentage of laboratory analyses, PES - Achieved percentage of examined samples and PLS - Achieved percentage of patients as users of laboratory services.

The sixth group of KPIs – Percentage of sanitary and expendable material consumption. Based on KPI PMC, the percentage of consumption of various types of materials such as: diagnostic, therapeutic, laboratory, sanitary, medical general and expendable

materials are monitored. The total value of sanitary and expendable material consumption is planned based on the invoiced realization from the previous year. Subsequent corrections, executed in the case of an increased volume of work, are provided.

RESULTS

In the following, the set of defined KPIs is applied to a concrete example, CHC "Dr Dragiša Mišović - Dedinje", for the years before and post-COVID. All data used are downloaded from the website of CHC "Dr Dragiša Mišović - Dedinje" [18] and are used exclusively for the research purposes of this paper. The first group of KPIs - Total employee participation. KPI PEPi presents the relation between the expected number of employees prescribed by the norm and the number of employees for the observed period, shown in percentage. It can be observed at the level of the institution and by groups of employees, whose presentation is given in Table 2. In CHC "Dr Dragiša Mišović - Dedinje", employees are segmented into the following groups: EMD - employed medical doctors, EF - employed pharmacists, EMNT - employed medical nurses and technicians, EHW - employed healthcare workers, ENMAW - employed non-medical administrative workers and ENMT - employed non-medical technicians.

The second group of KPIs - Hospital bed capacity utilization. This set of KPIs can be calculated at the level of the institution and the level of organizational units, i.e. clinics and hospitals. The number of hospitalized patients is a variable category and directly affects the occupancy of the hospital beds, i.e. days of hospitalization. CHC "Dr Dragiša Mišović - Dedinje" is segmented into the following organizational units: SC - Surgery Clinic; IMC – Internal Medicine Clinic; ARD - Anesthesia and Reanimation Department; URL - Urology Clinic; PH – Psychiatric Hospital; OGC – The Obstetrics and Gynecology Clinic; ORL - Otorhinolaryngology Hospital; DN – Department for Neurology; HCLT - Hospital for Children's Lung Diseases and Tuberculosis; ES – Endoscopy Service; PM –Physical Medicine; LD – Laboratory Diagnostics; RD - Radiological Diagnostics. The values of KPI PHP at the CHC level and all organizational units where patients are hospitalized for CHC "Dr Dragiša Mišović - Dedinje" are shown in Table 3.

The achieved percentage of hospitalization days varies and depends on the condition of the patients. It directly affects other KPIs, such as ADT. The values of KPI PHD for CHC "Dr Dragiša Mišović - Dedinje" at the level of CHC and all organizational units where patients are hospitalized are shown in Table 4.

The average duration of treatment per patient is closely related to the days of hospitalization, and the cause of the variability of this KPI is the difference in the health status of the patients. Each clinic and hospital have patients with different severity of health conditions,

Table 2. KPI PEP values at the CHC level and by employee groups in the years before and post-COVID

No.	*KPI* *PEP*	Before COVID (2019) Values in [%]	Post-COVID (2022) Values in [%]	PEP_{2022}-PEP_{2019} [%]
1	PEP	90.42	90.13	-0.29
2	PEP_{EMD}	91.74	108.00	16.26
3	PEP_{EF}	64.81	87.59	22.78
4	PEP_{EMNT}	88.70	83.71	-4.99
5	PEP_{EHW}	74.07	86.41	12.34
6	PEP_{ENMAW}	153.06	150.51	-2.49
7	PEP_{ENMT}	84.56	85.11	0.55

Table 3. KPI PHP values at the CHC level and by organizational units in the years before and post-COVID

No.	*KPI PHP*	Before COVID (2019) Values in [%]	Post-COVID (2022) Values in [%]	PHP_{2022}-PHP_{2019} [%]
1	*KPI PHP*	58.40	38.82	-19.58
2	PHP_{SC}	64.38	36.89	-27.49
3	PHP_{IMC}	68.34	29.35	-39.00
4	PHP_{ARD}	42.28	50.20	7.92
5	PHP_{URL}	44.33	48.42	4.09
6	PHP_{PH}	45.53	28.63	-16.90
7	PHP_{OGC}	60.26	65.35	5.10
8	PHP_{ORL}	47.11	111.87	64.76
9	PHP_{DN}	50.17	55.91	5.74
10	PHP_{HCLT}	50.87	175.53	124.66

and for this reason, it is necessary to measure the KPI ADT for each clinic and hospital separately. KPI ADT values for CHC "Dr Dragiša Mišović - Dedinje" at the level of CHC and organizational units are shown in Table 5.

The average occupancy of beds is directly related to the health condition of hospitalized patients. If the health condition is worse, the assumption is that the hospitalization days will be longer, and therefore the occupancy of the beds. The values of KPI AOB for CHC "Dr Dragiša Mišović - Dedinje" at the level of CHC and organizational units are shown in Table 6.

The third group of KPIs - Percentage of performed specialist examinations. Specialist examinations include ambulance and infirmary examinations and can be measured at the level of the institution and special organizational units. For CHC "Dr Dragiša Mišović - Dedinje", values for KPI PSE are shown in Table 7.

The fourth group of KPIs - Percentage of performed operations. The fourth group of KPIs consists of KPI POP - achieved percentage of operated patients and KPI PPP - achieved percentage of performed operations, which are observed and measured only by SC, URL, OGC and ORL. The values of these KPIs for CHC "Dr Dragiša Mišović - Dedinje" on the level of CHC, clinics and hospitals are shown in Table 8.

Observed at the level of CHC, clinics and hospitals, KPI PPP values for CHC "Dr Dragiša Mišović

Table 4. KPI PHD values at the CHC level and by organizational units in the years before and post-COVID

No.	*KPI PHD*	Before COVID (2019) Values in [%]	Post-COVID (2022) Values in [%]	PHD_{2022}-PHD_{2019} [%]
1	*KPI PHD*	50.61	35.65	-14.96
2	PHD_{SC}	55.56	36.43	-19.13
3	PHD_{IMC}	52.43	34.16	-18.27
4	PHD_{ARD}	63.49	43.76	-19.73
5	PHD_{URL}	54.20	30.46	-23.74
6	PHD_{PH}	48.18	27.79	-20.39
7	PHD_{OGC}	48.09	53.58	5.49
8	PHD_{ORL}	50.85	19.10	-31.75
9	PHD_{DN}	40.09	21.34	-18.75
10	PHD_{HCLT}	43.77	14.11	-29.66

Table 5. KPI ADT values at the CHC level and by organizational units in the years before and post-COVID

No.	KPI ADT	Before COVID (2019) Values in [day/patient]	Post-COVID (2022) Values in [day/patient]	ADT_{2022}-ADT_{2019} [day/patient]	ADT_{2022}-ADT_{2019} [%]
1	*KPI ADT*	0.86	0.92	0.06	6.40
2	ADT_{SC}	0.87	0.98	0.11	12.82
3	ADT_{IMC}	0.76	1.17	0.41	53.24
4	ADT_{ARD}	1.50	0.89	-0.61	-40.58
5	ADT_{URL}	1.19	0.96	-0.24	-19.83
6	ADT_{PH}	1.06	0.96	-0.10	-9.82
7	ADT_{OGC}	0.80	0.82	0.02	-2.94
8	ADT_{ORL}	1.07	0.96	-0.11	-10.64
9	ADT_{DN}	0.80	0.98	0.18	22.59
10	ADT_{HCLT}	0.85	1.67	0.82	95.51

Table 6. KPI AOB values at the CHC level and by organizational units in the years before and post-COVID

No.	KPI AOB	Before COVID (2019) Values in [%]	Post-COVID (2022) Values in [%]	AOB_{2022}-AOB_{2019} [%]
1	*KPI AOB*	101.40	71.88	-29.52
2	AOB_{SC}	111.36	73.49	-37.87
3	AOB_{IMC}	105.22	68.96	-36.26
4	AOB_{ARD}	127.36	88.25	-39.11
5	AOB_{URL}	108.72	61.38	-47.34
6	AOB_{PH}	96.72	55.95	-40.77
7	AOB_{OGC}	96.50	107.99	11.49
8	AOB_{ORL}	101.96	38.61	-63.35
9	AOB_{DN}	80.41	43.10	-37.31
10	AOB_{HCLT}	87.67	28.33	-59.34

- Dedinje" are shown in Table 9.

The fifth group of KPIs - Percentage of performed laboratory services. The values of three KPIs that present the fifth group of KPIs for CHC "Dr Dragiša Mišović - Dedinje" at the level of CHC are shown in Table 10.

The sixth group of KPIs - Percentage of sanitary and expendable material consumption. KPI PMC is monitored and measured at the institution level, and the values for CHC „Dr Dragiša Mišović – Dedinje" are shown in Table 11.

DISCUSSION

Based on the data shown in Tables 2-11, a comparative analysis of the values of the defined KPIs for the years before and after the pandemic COVID-19 was performed. As for the first group of KPIs (Total employee participation), at the level of CHC "Dr Dragiša Mišović - Dedinje" there was a decrease in the total number of employees (PEP) by only 0.29 [%]. Regarding the groups of employees, the number of employed pharmacists (PEPEF) increased by 22.78 [%], while the number of

Table 7. KPI PSE values at the CHC level and by organizational units in the years before and post-COVID

No.	KPI PSE	Before COVID (2019) Values in [%]	Post-COVID (2022) Values in [%]	PSE_{2022}-PSE_{2019} [%]
1	*KPI PSE*	51.77	32.45	-19.33
2	PSE_{SC}	62.22	30.23	-31.99
3	PSE_{IMC}	57.26	26.34	-30.92
4	PSE_{ARD}	58.85	28.71	-30.14
5	PSE_{URL}	47.59	19.01	-28.58
6	PSE_{PH}	41.66	34.56	-7.10
7	PSE_{OGC}	58.09	63.47	5.39
8	PSE_{ORL}	48.49	32.31	-16.18
9	PSE_{DN}	52.43	27.87	-24.56
10	PSE_{HCLT}	40.10	23.60	-16.50

Table 8. KPI POP values at the CHC level and by organizational units in the years before and post-COVID

No.	KPI POP	Before COVID (2019) Values in [%]	Post-COVID (2022) Values in [%]	POP_{2022}-POP_{2019} [%]
1	*KPI POP*	58.66	39.50	-19.15
2	POP_{SC}	67.62	31.56	-36.06
3	POP_{URL}	44.55	26.19	-18.36
4	POP_{OGC}	61.89	62.91	1.02
5	POP_{ORL}	52.23	22.70	-29.52

Table 9. KPI PPP values at the CHC level and by organizational units in the years before and post-COVID

No.	KPI PPP	Before COVID (2019) Values in [%]	Post-COVID (2022) Values in [%]	PPP_{2022}-PPP_{2019} [%]
1	*KPI PPP*	61.45	37.69	-23.75
2	PPP_{SC}	77.69	33.15	-44.54
3	PPP_{URL}	48.58	24.10	-24.48
4	PPP_{OGC}	61.89	61.40	-0.50
5	PPP_{ORL}	52.23	22.05	-30.18

Table 10. Values of KPIs PLA, PES and PLS at the CHC level in the years before and post-COVID

No.	KPIs	Before COVID (2019) Values in [%]	Post-COVID (2022) Values in [%]	KPI_{2022}-KPI_{2019} [%]
1	*KPI PLA*	66.31	50.57	-15.74
2	*KPI PES*	68.39	46.67	-21.73
3	*KPI PLS*	60.58	50.57	-10.01

Table 11. KPI PMC values at the CHC level in the years before and post-COVID

No.	KPI PMC	Before COVID (2019) Values in [%]	Post-COVID (2022) Values in [%]	PMC_{2022}-PMC_{2019} [%]
1	*KPI PMC*	69.57	51.81	-17.75

employed medical nurses and technicians (PEPEMNT) decreased by 4.99 [%].

Regarding the second group of KPIs (Hospital bed capacity utilization), the total number of hospitalized patients at the CHC level (PHP) decreased by 19.58 [%], where the largest decrease of 39.00 [%] was observed at the Internal Medicine Clinic (PHPIMC) and the largest increase by as much as 124.66 [%] was observed in the Hospital for Children's Lung Diseases and Tuberculosis (PHPHCLT). The achieved percentage of hospitalization days per patient at the CHC level (PHD) decreased by 14.96 [%], where the largest decrease was observed in the Otorhinolaryngology Hospital (PHDORL) by 31.75 [%] and an increase of 5.49 [%] in the Obstetrics and Gynecology Clinic (PHDOGC). The average duration of treatment per patient at the CHC level (ADT) increased by only 0.06 [day/patient], which is an increase of 6.40 [%], where the largest increase was observed in the Hospital for Children's Lung Diseases and Tuberculosis (ADTHCLT) by 0.82 [day/patient], i.e. 95.51 [%], and the largest reduction in the Anesthesia and Reanimation Department (ADTARD) by 0.61 [day/patient], i.e. 40.58 [%]. Regarding average bed occupancy per patient, at the CHC level, this KPI AOB decreased by as much as 29.52 [%], where the highest decrease was observed in the Otorhinolaryngology Hospital (AOBORL) by as much as 63.35 [%], while the largest increase was observed in the Obstetrics and Gynecology Clinic (AOBOGC) by 11.49 [%]. The conclusion based on the values of the observed KPIs is that in the post-COVID period, there was a decrease in hospital bed capacity utilization.

The third group of KPIs (Percentage of performed specialist examinations) at the CHC level (PSE) decreased by 19.33 [%], where the largest decrease was observed at the Surgery Clinic (PSESC) by 31.99 [%], while an increase of 5.39 [%] was observed at the Obstetrics and Gynecology Clinic (PSEOGC).

The fourth group of KPIs (Percentage of performed operations) consists of two KPIs, POP and PPP. The total achieved percentage of operated patients at the CHC level (POP) decreased by 19.15 [%], where the largest decrease was observed at the Surgery Clinic (POPSC) by as much as 36.06 [%], and an increase of only 1.02 [%] was observed in the Obstetrics and Gynecology Clinic (POPOGC). As for the achieved percentage of operations performed at the CHC level (PPP), it decreased by 23.75 [%], and the largest decrease was observed at the Surgery Clinic (PPPSC) by as much as 44.54 [%], while there is no increase at any clinic. Therefore, the total percentage of performed surgeries decreased in the post-COVID year.

The fifth group of KPIs (Percentage of performed laboratory services) at the CHC level, has also a noticeable decrease: the percentage of performed laboratory analyses (PLA) by 15.74 [%], the total percentage of examined samples (PES) by 21.73 [%] and the total number of patients as users of laboratory analyses (PLS) for 10.01 [%]. Therefore, the total percentage of performed laboratory services decreased in the post-COVID year.

The last, sixth group of KPIs (Percentage of sanitary and expendable material consumption) PMC also shows a decrease in the consumption of sanitary and expendable material consumption in the post-COVID year by 17.75 [%].

In conclusion, for improving healthcare institutions' efficiency after COVID-19, a set of 12 KPIs is defined. Based on that, an analysis and comparison of the observed KPI values of one of the most important healthcare institutions in the Republic of Serbia, CHC "Dr Dragiša Mišović - Dedinje", was performed. The analysis and comparison of data were conducted for the first six months of 2019, the year before the pandemic COVID-19, and the first six months of 2022, the year after the pandemic COVID-19.

By identifying, measuring and comparative analysis of intently selected KPIs, it can be concluded that the consequences of the pandemic COVID-19 are still present in the observed healthcare institution. The values of the observed KPIs indicate that with the increase in the volume of work and number of health employees in 2022, a slight balance is established with the results of the work of this institution in relation to 2019. Based on the analysis of the data and the presented results, the conclusion is that for all observed KPIs (both individually and by groups) there was a decrease or an imperceptible increase in the post-COVID period, given that during the pandemic COVID-19, CHC was fully in COVID mode and treated only COVID patients. The reductions in KPIs values indicate that CHC's capacity is slowly returning to regular capacity and that it should strive to meet the prescribed norms of the observed groups of KPIs. The largest decrease in individual KPIs was observed in the achieved average occupancy of beds in the Otorhinolaryngology Hospital (AOBORL) by as much as 63.35 [%], while the largest increase, as much as 124.66 [%] was observed in the achieved percentage of hospitalized patients in the Hospital for Children's Lung Diseases and Tuberculosis (PHPHCLT).

Based on all previously shown data and analyses, the recommendations for improving the healthcare efficiency in healthcare institutions in the post-COVID

regime are:

- Reduction of the waiting list for specialist examinations and operations created during the pandemic COVID-19. It can be achieved by increasing the number of specialist examinations and operations until the planned norm is fulfilled. During the pandemic COVID-19, there was a ban on examinations, operations and hospitalization of non-COVID patients. The increase in the capacity of performed specialist examinations, as well as the operations of patients who have been waiting for it since the beginning of the pandemic, will lead to an increase in hospitalized patients and fulfillment of the planned norm;

- Online consultations by application of digital technologies. It will reduce the number of physically present patients when there is no need;

- Coordination of activities, employees and all types of examinations on the level of the institution. Healthcare institutions usually consist of several different departments and clinics, so synchronization of activities can be done on the level of an institution;

- Effective management of material and non-material resources. This will lead to the creation of timely material procurement plans and timely intervention to prevent the escalation of problems;

- Adapting the capacity of specialist examinations to the number of post-COVID patients with post-COVID symptoms. Those patients need to be examined and monitored, with frequently detailed analyses, especially for patients who had problems with the heart, muscles, lungs and mental health before the pandemic;

- Organization of additional training for employees. Especially to those who started working during the pandemic COVID-19, to ensure a better distribution of the necessary skills among all employees.

As an additional recommendation for increasing the efficiency of healthcare services in healthcare institutions, it is proposed to regularly measure and monitor the values of KPIs defined in this paper, as well as to compare their values with the defined objective, i.e. the desired values. It is important to emphasize that is necessary to take corrective measures when the values of KPIs do not reach the desired values.

Conflict of interest

The authors declare that they have no conflict of interest.

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