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Trends in Spending on Staff Expenditures at Maria Aparecida Pedrossian Hospital: A Forecast with Time Series

ABSTRACT

Objective: Analyze and forecast personnel expenses at Humap for the period from 2015 to 2022.

Method: The method was quantitative, using temporal data and a combination of statistical forecasting methods (ETS, Theta, ARIMA, NNAR, TBATS, and STL).

Originality/Relevance: Demonstrates the possibility for managers to project new hires based on patterns observed in historical data to measure the variability of personnel expenses.

Results: A model for predicting performance using Humap personnel expenses was developed to support public policies in the personnel area.

Theoretical/Methodological contributions: Presents a model of public policies for people management based on personnel expenses.

Social/Management contributions: Presents the possibility of modeling personnel quantity guidelines so that these variations do not affect the continuous actions that improve the public services provided to society daily.

Keywords: Performance, Personnel Expenses, Public Policies.

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1 INTRODUCTION

Human resource management in healthcare is essential for ensuring the quality, capacity, and satisfaction of both the population served and healthcare professionals (Sela & Soares, 2014; Silva, Leite & Rodrigues, 2016).

The challenges of human resource management in the healthcare sector include outsourcing, payroll, training, and personnel recruitment, all of which require continuous investment to meet social and legal needs (Kashiwakura & Oliveira, 2021). Other challenges include the size of waiting lists for appointments, exams, and surgeries; the number of available hospital beds; the availability of medications; and the capacity, quality, and satisfaction with care in the Unified Health System (SUS) (Ministry of Health, 2015; Lopes, 2017).

These challenges lead to dissatisfaction among healthcare workers regarding salaries, working conditions, and job security, given the responsibilities they assume (Guedes et al., 2013). User dissatisfaction is attributed to a shortage of doctors and appointment slots, long waiting lists, delayed referrals for tests and specialists, insufficient medication, and inadequate physical space in healthcare units (Medeiros et al., 2007; Almeida, Alves & Leite, 2010). Users also report the importance of free services, welcoming staff, empathetic listening, professional qualifications, and team integration (Berto et al., 2016).

In the state of Mato Grosso do Sul, among the public hospitals, the Maria Aparecida Pedrossian Hospital (Humap) stands out. It is linked to the Federal University of Mato Grosso do Sul (UFMS) on its campus in Campo Grande, the state capital, and is operated by the Brazilian Hospital Services Company (Ebserh). Humap is a state reference center for infectious diseases and highly complex procedures in the treatment of HIV patients, cardiovascular surgery, hemodialysis and neurology, high-risk pregnancies, tomography, and other treatments linked to the Unified Health System (SUS) (Humap, 2023).

Given the context of human resource management at Ebserh, our research hypothesis is: Is there a linear growth trend in personnel expenses at Humap? The objective is to analyze the trend in personnel expenses at Humap and forecast them. The period covered was from 2015 to 2022 because the hospital's private data was accessible.

Analyzing personnel expenses at Humap is relevant given the national financial challenges in the public health sector. According to IBGE (2024), Brazil invested only about 4% of its GDP in health in 2021, below the 6% recommended by the Pan American Health Organization, reflecting on the quality of services provided. In this context, forecasting personnel expenses at Humap is fundamental for efficient resource management and for maintaining the quality of care for the population.

In the next section, we contextualize the institution and the low number of studies found in the literature review. Following that, we will present the methods and data used; describe the results; and finally, offer our concluding remarks.

2 LITERATURE REVIEW

Public policies on personnel expenditure refer to the guidelines and regulations established by the government regarding the financial resources allocated to public employees and civil servants. These policies aim to ensure efficient and balanced management of personnel expenses, to manage personnel resources and provide quality public services effectively, and to manage personnel planning for the appropriate sizing of the workforce, considering the needs and demands of public bodies and entities (Rezende et al., 2007; Monteiro et al., 2019).

According to Law No. 101 of 2000, which establishes limits on personnel expenses for public bodies, their needs must be considered, ensuring that resources are allocated efficiently and effectively without compromising essential services (Sousa, 2018).

The Fiscal Responsibility Law establishes limits on personnel expenses, provided that these limits are realistic and take into account the government's long-term financing capacity (Brazil, 2000). Martins (2003) states that expenditure can be understood as the purchase of a product or service that entails a financial sacrifice for the entity to achieve its objectives, for example, a raw material or an outsourced service within the organization.

According to Santos (2013), hospital management demands cost control and efficient use of available resources. In this context, the adoption of a cost accounting system becomes indispensable, not only to meet fiscal requirements but mainly to support the decision-making process. However, as Dallora (2007) observes, implementing this type of system in hospitals is a complex, time-consuming process, due to the diversity of services and professionals involved and the large volume of information required. Therefore, Brazilian hospitals must have an adequate cost model that enables precise cost measurement for each service.

Gonçalves and Mascarenhas (2013) highlight that hospital organizations incur high costs and deliver unsatisfactory quality, which generates unease and dissatisfaction among patients, healthcare professionals, employees, service providers, suppliers, and the government itself. This reality highlights the complexity of hospital administration and the limitations of traditional cost management methods in this sector.

Regularly monitoring the relationship between personnel expenses and revenues is fundamental to assessing fiscal sustainability. If the proportion of personnel expenses is constantly growing and approaching or exceeding established limits, corrective actions may be necessary, such as controlling hiring, reviewing benefits, or improving process efficiency (Brazil, 2000).

It is essential to assess the impact of salary adjustments when establishing salary adjustment policies for public servants, considering factors such as inflation, economic

growth, tax revenue, and the government's financing capacity to define limits or criteria for adjustments (Giuberti, 2005).

Hospital managers need to make decisions based on accounting information. Activity-Based Costing (ABC), which estimates costs by activity, is considered the most suitable for hospitals, as it enables systematic mapping and analysis of processes and activities. However, it does not replace absorption costing, which is required by Brazilian law. Thus, both methods should be used in a complementary way: absorption costing for tax purposes and ABC to provide management information that assists in decision-making (Costa et al., 2021).

Another aspect related to the costs of hospital organization is technological innovation. When viewed individually, innovations increase service costs; however, they also increase productivity and the quality of healthcare services, leading to greater patient comfort and improved healing efficiency (Rodrigues et al., 2016).

For the Nursing Division Directors of a university hospital, cost management is an essential tool for nurses' work. Cost management underpins the proper use of material resources to promote patient safety, avoid waste, and minimize financial losses (Lee & Lima, 2025).

According to Silva et al. (2016, p. 3), human resource management should: “seek the best possible alignment between people's behavior and the organization's strategies and goals.” Therefore, human resource management is essential to the development of organizational activities by recruiting, training, developing, and motivating people to achieve objectives and deliver services to society.

Marras (2016) points out that human resource management in organizations has the crucial function of focusing on the effective management of employees, so that, for example, conflict management, succession planning, diversity, and inclusion are aligned with the need to understand individual and organizational interactions and relationships.

Farias and Araújo (2017) point out that communication and work processes need improvement in hospital administrative practices. The authors suggest participatory management and the incorporation of methodological practices as means of addressing the problem.

According to Cruz et al. (2018, p. 2), assessing financial capacity and identifying resource availability help minimize organizational debt. Knowing the limits of personnel expenses is a way to ensure long-term fiscal sustainability, provided they are compatible with revenue collection capacity (Santos & Ferreira, 2017).

Korzenowski et al. (2022) present a review of the scientific literature on hospital management. They conclude that there is little research on the subject and that the studies use a descriptive, qualitative methodology, which creates a gap for future studies, particularly in public hospitals, which are scarce and not robust.

According to Porto and Granetto (2020), human resource management is essential for hospital institutions to function efficiently. In this sense, it is indispensable that managers implement innovative actions, align employees with current demands and contexts, and ensure compliance with institutional principles and objectives.

Researching financial data on human resource management in hospitals is not easy. For example, the limitation of the research by Campos et al. (2022) was the difficulty in obtaining financial information (such as Costs, Qualifications, Works/Renovations) because hospital managers were resistant to providing the necessary information. Thus, we advanced the task's complexity by gaining access to a hospital's financial data.

Human resource management policies must be agile in adapting to established changes and updates to rules and regulations, while also prioritizing employees' physical and emotional well-being. People are becoming ill due to excessive authoritarianism and a lack of conflict resolution, which is often not mediated by a culture of communication (Fiuza, 2010).

It is also important to highlight that fiscal sustainability is an ongoing objective and requires a comprehensive approach to public finance management. Furthermore, it is crucial to consider specific characteristics and regulations when establishing personnel expenditure policies (Cruz et al., 2018).

It is not our goal to apply a theory to the case since the research is exploratory. However, we highlight the findings of Eldenburg, Xavier, and Krishnan (2017), who argue that it is unlikely that a single theory can comprehensively explain accounting systems in US hospitals, given their diverse ownership structures. Thus, the authors apply Agency Theory to hiring/compensation, but note the low generalizability of results. Transaction Cost Theory is useful for understanding physician-hospital hiring, but it falls short by failing to account for sociological influences on hiring.

Institutional Theory explains how hospitals conform to legal, moral, and cultural pressures, thereby gaining greater legitimacy, stability, and resources when faced with difficulties. Resource Dependence Theory (RDT) analyzes strategies to reduce environmental uncertainties, affecting technological choices. Hospitals operating in less munificent financial and human resource environments employ relatively inexpensive, labor-intensive technologies (Eldenburg et al., 2017).

Little is known about which cost accounting methods hospitals most commonly use. Hospitals have not adopted sophisticated accounting systems because the sector's characteristics make the costs of such adoption high and the benefits relatively low. Health plans are creating incentives for patients to compare service prices, so hospitals may face pressure to set prices at levels that reflect costs. Looking ahead, accounting information will become more important in hospital management than it has been in the past (Carroll & Lord, 2016).

Sanz and Sanz (2022) advocate the use of machine learning techniques in hospital management. This would be a new way to predict hospital financial costs using an Artificial Neural Network, which would assist hospital administrators in their resource planning decisions and could improve the quality of health services and medical care for patients.

3 METHODOLOGICAL APPROACH

This research is classified as quantitative, analyzing the performance dynamics of the public policy on personnel expenses at Humap. The research approach is exploratory-descriptive in the context of personnel expenses in a public hospital, and statistics are used as the data analysis technique.

This research aims to analyze personnel expenditure trends at Maria Aparecida Pedrossian Hospital through a time series forecast of monthly payroll costs, including salaries, performance bonuses, and substitutions, linked to the Humap payroll. The study covers the period from 2015, when Ebserh's activities began at Humap-UFMS, to 2022.

The data collection process was carried out using private documents that supported the intended research performance. According to Creswell (2007), the data collection process involves defining the study's boundaries and preparing the necessary context to discuss the research-related issues.

3.1 Data source and processing

The flow of health resources at the national level of the Ministry of Health (Personnel and Social Charges, Interest and Debt Charges, Other Current Expenses, Investments, Financial Investments, and Contingency Reserve) was determined, for a simple sampling of the period between 2015 and 2022. Budgetary expenses were R\$1,204,514,085,644.18 (One

trillion and two hundred and four billion reais); The realized budget was R\$1,008,345,047,667.33 (One trillion and eight billion reais).

Humap receives financial support from agreements (See Table 1) for contracting health services between the Municipal Secretariat of Public Health of Campo Grande (SESAU), with the participation of the State Secretariat of Health (SES) and Ebserh, together with Humap (Ebserh, 2022), with the receipt of pre-fixed and post-fixed resources conditioned on the fulfillment of the agreement's goals.

Table 1

Financial information: Agreement between 2021 and 2022

Description	Monthly	Annual
Estimated budget program		R\$48,187,594.20 (forty-eight million, one hundred and eighty-seven thousand, five hundred and ninety-four reais and twenty cents)
Pre-fixed budget	amount of R\$3,393,060.91 (three million three hundred and ninety-three thousand sixty reais and ninety-one cents)	value R\$40,716,731.02 (forty million, seven hundred and sixteen thousand, seven hundred and thirty-one reais and two cents)
Post-fixed budget	amount of R\$622,571.93 (six hundred and twenty-two thousand, five hundred and seventy-one reais and ninety-three cents)	value R\$7,470,863.18 (seven million, four hundred and seventy thousand, eight hundred and sixty-three reais and eighteen cents).

Source: research data (2023).

3.2 Institutional Scenario of Humap within the Mato Grosso do Sul (MS) Society

Specifically, as the object of this study, the personnel expenditure policy, Humap, defined by the Internal Regulations of May 24, 2021, is a High Complexity Hospital whose purpose is to promote assistance, teaching, research, and extension in the area of health and related fields. The supplementary body of UFMS, a legal entity under public law, created by Law No. 6,674 of June 5, 1979, and linked to the Ministry of Education (MEC), aims to provide excellent healthcare within the SUS (Brazilian Public Health System), constituting a suitable practice setting for teaching, research, and outreach for faculty and students. It

encompasses Specialty Clinics, a Surgical Center, an Obstetrics Center, Adult and Pediatric ICUs, a Neonatal ICU, a Coronary Care Unit (CCU), Adult and Pediatric Emergency Medical Services (PAM and PAM PED), Diagnostic Imaging, a Radiology Service, a Breast Milk Bank, and Hemodialysis. It offers medical residencies in 21 specialties (Humap, 2023).

Administered by Ebserh since December 2013, measures have been adopted to improve the physical infrastructure, and several sectors have undergone renovations. It operates under two labor regimes, RJU and CLT2, and its organizational structure encompasses two sets of accounting laws: public accounting under Law No. 4,320/64 and private accounting under Law No. 6,404/76, as well as outsourced services (Humap, 2023).

Table 2 presents information on the employment status of professionals at Humap, classified by their functional status under the RJU (Single Legal Regime), the CLT (Consolidation of Labor Laws), and outsourced contracts.

Table 2

Human resources by relationship, Humap, 2019-22

Human Resources by employment relationship	2019	2020	2021	2022
Transferred (UFMS and other affiliations)	12	10	14	32
Commissioners	1	1	1	1
Ebserh	940	983	1006	1030
UFMS	519	505	459	441
Subtotal 1	1.472	1.499	1.480	1.504
Outsourced Cleaning Services (contract termination by leadership on 06/06/2022)	102	102	124	0
Outsourced support (Arauna)	66	66	59	59
Outsourced support (Phênix)	27	27	22	22
Outsourced support (CG Community Council)	0	0	20	20
Outsourced support assistance (Arauna)	116	116	132	132
Outsourced administrative support (Guatos)	0	29	29	29
Outsourced Cleaning Services (Orbenk starting on 07/06/2022)	0	0	0	112
Subtotal 2	311	340	386	374
Total	1.783	1.839	1.866	1.878

Source: DivGP/GA/SUP-Humap-UFMS; Ucont/SAD/DAF/GA-Humap-UFMS (2022).

There is an increase in the number of Ebserh employment contracts, in contrast to the reduction in UFMS employment contracts, while the overall number of employment contracts shows a slight increase. According to the data, expenses paid in 2020, 2021, and 2022 accounted for 27.64%, 31.02%, and 18.32%, respectively, of the effective transfers of financial revenue.

3.3 Specification of statistical models

In the first stage, we analyzed the receipt of monthly data from DDP6, extracted from SIAPE7, and the receipt of monthly data extracted from SIGP Menthorh8; in the second stage, we classified the quantitative and financial data; in the third stage, we created a spreadsheet with the relevant classified data; and in the last stage, we applied time series analysis using the RStudio program (a programming language for graphs and statistical calculations - in this work, version 2023.06 Build 421 was used) in order to understand the relationships between the chosen data and the performance of personnel expenses at Humap.

We analyzed the financial data from the payrolls of permanent Ebserh employees holding positions, whether they are permanent employees of Humap or public servants seconded from UFMS, as shown in Table 3.

Table 3

Links by year from 2015 to 2022

Year	2015	2016	2017	2018	2019	2020	2021	2022
Total Link	635	757	817	949	936	1.037	1.104	1.227

Source: research data (2023).

Table 4

Total Selection Data (Values in Brazilian Reais - R\$)

Year	Gross Total	Salaries	Bonus for Performing a Job	Job substitutions
2015	31.860.002,97	18.827.747,67	2.644.017,33	72.050,36
2016	75.752.064,04	36.547.220,88	3.350.518,02	218.097,34
2017	90.375.212,12	48.222.949,88	4.131.438,97	185.998,13
2018	111.568.676,98	56.908.248,45	4.106.737,20	333.288,67
2019	112.375.158,92	64.438.885,56	4.414.755,59	499.841,95
2020	129.616.682,16	66.896.252,11	4.792.617,85	415.964,29
2021	145.990.321,36	71.079.461,99	4.814.176,99	397.962,25
2022	152.234.671,68	79.355.101,45	5.184.315,22	405.489,09
TOTAL	849.772.790,23	442.275.867,99	33.438.577,17	2.528.692,08

In this study, the application of a public policy on personnel expenses, in accordance with the proposed problems and objectives, was first put to descriptive statistics for the period established for analysis, the number of employment contracts (number of employees) at Humap, and the amounts spent on payroll, as shown in Tables 5 and 6.

Table 5

Descriptive statistics on the number of employment contracts at Humap between 2015 and 2022

	Number of Links
Average	860,8632
Standard error	21,99646
Median	936
Mode	679
Standard deviation	214,395
Sample variance	45965,2
Interval	1085
Minimum	142
Maximum	1227
Count	95

Regarding the number of employment relationships (Table 3), the data indicate that over approximately 8 years (95 months), the average number of workers employed by Humap was approximately 861. According to IBGE statistics, the state of Mato Grosso do Sul had

approximately 65.3% of its population employed; 50,000 people were unemployed, representing an unemployment rate of 3% in the 4th quarter of 2022.

Table 6

Descriptive statistics of total earnings on Humap payrolls between 2015 and 2022

Salaries	
Average	4655535,453
Standard error	160302,5294
Median	5352149,06
Mode	3849515,88
Standard deviation	1562435,787
Sample variance	2,44121E+12
Interval	7936431,39
Minimum	343337,19
Maximum	8279768,58
Count	95

In the same context, for total payroll expenses, the descriptive analysis data (Table 6) show that the average for the analyzed period, from 2015 to 2022, was R\$4,655,535.45 (four million, six hundred and fifty-five thousand, five hundred and thirty-five reais and forty-five cents). Thus, it can be inferred that the average total expenditure per employment relationship with Humap, in the analyzed period, was R\$5,407.98 (five thousand, four hundred and seven reais and ninety-eight cents).

3.4 Data Analysis Procedures

After data collection, indicators were constructed in tables and graphs for time-series analysis, using statistical forecasting methods such as ARIMA, ETS, THETA, NNAR, TBATS, and STL, with parameters set according to Hyndman and Athanasopoulos (2021). The values found were compared with the primary result to assess their potential for forecasting future values, allowing managers to determine the trend in Humap's payroll. This

would enable managers to make projections about new hires and negotiations with the Federal Government, based on patterns observed in historical data.

It is important to highlight that, although the models are useful for many time series, they may not be the most suitable. Therefore, the analysis of the aforementioned models was conducted by combining forecasts to obtain more accurate predictions. For the statistical modeling techniques, the models described in Table 7 were used.

Table 7

Time series forecasting models and their characteristics

Method	Authors/Year	Description
ARIMA	Hyndman & Athanasopoulos, 2018	This model consists of three main components: Autoregression (AR), Integration (I), and Moving Average (MA). It uses historical data to identify patterns and generate forecasts that can aid management.
ETS	Assimakopoulos & Nikolopoulos, 2000	Based on the decomposition of the series into Error (E), Trend (T), and Seasonality (S). The choice of parameters depends on the presence and intensity of trends and seasonality.
THETA	Assimakopoulos & Nikolopoulos, 2000	Consider Seasonality (S) and Trend (T), adjusting the series for seasonality using a classic multiplicative decomposition before applying the THETA method.
Forecast Combination	Hyndman & Athanasopoulos, 2018; Bates & Granger, 1969	It integrates results from different forecasts obtained by distinct methods to produce more accurate and reliable estimates.
NNAR	Hyndman & Athanasopoulos, 2018	The Neural Network Autoregressive model combines neural networks and autoregressive models to capture nonlinear dependencies in time series.
TBATS	Hyndman & Kourentzes, 2011	A model that incorporates trigonometric functions for multiple seasonal variations, Box-Cox transformations to stabilize variance, ARIMA errors for temporal dependence, as well as complex trend and seasonality.
STL	Cleveland, Cleveland, McRae, & Terpenning, 1990	Loess-based decomposition procedure for separating a time series into trend, seasonality, and residual components.

3.5 Validation procedures

The proposed time series analysis combines statistical methods to predict a period of up to 24 months based on collected data. For this research, the application of accuracy was also considered, given its importance in evaluating simulation precision and determining the

classes of collected data. Accuracy is a commonly used metric to assess the quality of applied models, ensuring that predictions are as precise as possible.

It is important to note that although employee salaries are pre-established, deflation, which directly affects salary amounts and can significantly affect income and purchasing power, cannot be ignored.

The following tables show the total distribution of monthly salaries by number of employment contracts from 2015 to 2022, with calculations deflated month by month and updated by the IPCA index, using the final index value of R\$6,667.94 relative to July 2023. We can observe that in January 2016, the margin showed the most significant deflation during the analyzed period, 23.98%, indicating that, in theory, the most significant negative adjustment in values occurred, even though no readjustment in employee salaries was observed. Conversely, the lowest index appeared in June 2019, with a variation of 0.01%. The average deflation during the analyzed period was approximately 1.28%.

Table 8

Total distribution of monthly earnings and number of employment contracts from 2015 to 2022 – adjusted for inflation.

Month/ Year	Vínc.	T. Venc. (R\$)	T. Venc. vinc. (μ)	Var. Deflac. (%)	I. Inicial (R\$)	IPCA (%)	Val. Atual. (R\$)	Var. Atual. (%)
Feb/15	142	343.337	2.418	-	4.160	1,6	3.875	-
Mar/15	209	682.649	3.266	35,0	4.215	1,6	5.167	33,3
Apr/15	273	1.004.081	3.678	12,6	4.245	1,6	5.777	11,8
May/15	326	1.170.337	3.590	-2,3	4.277	1,6	5.597	-3,1
Jun/15	383	1.431.073	3.736	4,0	4.310	1,5	5.780	3,2
Jul/15	431	1.599.011	3.710	-0,7	4.337	1,5	5.704	-1,3
Aug/15	483	1.841.286	3.812	2,7	4.347	1,5	5.848	2,5
Sep/15	527	2.057.693	3.905	2,4	4.370	1,5	5.958	1,8
Oct/15	577	2.305.337	3.995	2,3	4.406	1,5	6.047	1,4
Nov/15	637	2.747.841	4.314	7,9	4.450	1,5	6.463	6,8
Dec/15	635	3.645.102	5.740	33,0	4.493	1,5	8.519	31,8
Jan/16	637	2.779.560	4.364	-23,9	4.550	1,5	6.394	24,9
Feb/16	682	2.986.761	4.379	0,3	4.591	1,5	6.360	-0,5

Month/ Year	Vínc.	T. Venc. (R\$)	T. Venc. vinc. (μ)	Var. Deflac. (%)	I. Inicial (R\$)	IPCA (%)	Val. Atual. (R\$)	Var. Atual. (%)
Apr/16	680	2.965.521	4.361	0,0	4.639	1,4	6.268	-0,5
May/16	679	2.953.091	4.349	-0,7	4.675	1,4	6.203	-1,0
Jun/16	679	2.976.503	4.384	0,7	4.692	1,4	6.230	0,4
Jul/16	683	2.995.134	4.385	0,0	4.716	1,4	6.200	-0,4
Aug/16	679	2.998.224	4.416	0,6	4.737	1,4	6.216	0,2
Sep/16	679	3.005.874	4.427	0,2	4.741	1,4	6.227	0,1
Oct/16	683	3.062.982	4.485	1,3	4.753	1,4	6.292	1,0
Nov/16	690	3.094.356	4.485	0,0	4.761	1,4	6.280	-0,1
Dec/16	757	3.736.055	4.935	10,0	4.776	1,4	6.891	9,7
Jan/17	779	3.849.516	4.942	0,1	4.794	1,4	6.873	-0,2
Feb/17	784	3.849.516	4.910	-0,6	4.810	1,4	6.807	-0,9
Mar/17	784	3.899.439	4.974	1,2	4.822	1,4	6.878	1,0
Apr/17	786	3.885.357	4.943	-0,6	4.828	1,4	6.826	-0,7
May/17	791	3.947.575	4.991	0,9	4.843	1,4	6.871	0,6
Jun/17	798	4.003.345	5.017	0,5	4.832	1,4	6.922	0,7
Jul/17	801	4.017.647	5.016	0,0	4.844	1,4	6.905	-0,2
Aug/17	809	4.074.419	5.036	0,4	4.853	1,4	6.920	0,2
Sep/17	814	4.129.634	5.073	0,7	4.861	1,4	6.959	0,5
Oct/17	817	4.176.945	5.113	0,7	4.881	1,4	6.984	0,3
Nov/17	817	4.183.887	5.121	0,1	4.895	1,4	6.976	-0,1
Dec/17	817	4.205.669	5.148	0,5	4.916	1,4	6.982	0,0
Jan/18	812	4.194.927	5.166	0,3	4.931	1,4	6.986	0,0
Feb/18	806	4.187.738	5.196	0,5	4.947	1,3	7.004	0,2
Mar/18	839	4.370.091	5.209	0,2	4.951	1,3	7.015	0,1
Apr/18	855	4.485.991	5.247	0,7	4.962	1,3	7.051	0,5
May/18	864	4.553.056	5.270	0,4	4.982	1,3	7.053	0,0
Jun/18	869	4.579.191	5.269	0,0	5.044	1,3	6.965	-1,2
Jul/18	875	4.914.568	5.617	6,5	5.061	1,3	7.400	6,2
Aug/18	873	4.935.236	5.653	0,6	5.057	1,3	7.455	0,7
Sep/18	871	4.901.935	5.628	-0,4	5.081	1,3	7.386	-0,9
Oct/18	878	5.015.553	5.712	1,5	5.104	1,3	7.463	1,0
Nov/18	952	5.390.546	5.662	-0,8	5.093	1,3	7.413	-0,6
Dec/18	949	5.379.417	5.669	0,1	5.101	1,3	7.410	0,0
Jan/19	947	5.352.149	5.652	-0,2	5.117	1,3	7.365	-60,0
Feb/19	948	5.367.977	5.662	0,1	5.139	1,3	7.347	-0,2
Mar/19	947	5.361.934	5.662	0,0	5.177	1,3	7.292	-0,7
Apr/19	949	5.379.287	5.668	0,1	5.207	1,3	7.259	-0,4
May/19	947	5.383.423	5.685	0,2	5.214	1,3	7.270	0,1
Jun/19	946	5.377.582	5.685	0,0	5.214	1,3	7.269	0,0
Jul/19	942	5.356.145	5.686	0,0	5.224	1,3	7.257	-0,1
Aug/19	939	5.340.877	5.688	0,0	5.230	1,3	7.252	0,0
Sep/19	943	5.342.775	5.666	-0,3	5.228	1,3	7.226	-0,3
Oct/19	938	5.396.547	5.753	1,5	5.233	1,3	7.331	1,4
Nov/19	937	5.397.554	5.760	0,1	5.260	1,3	7.303	-0,3
Dec/19	936	5.382.636	5.751	-0,1	5.320	1,3	7.207	-1,3
Jan/20	936	5.365.965	5.733	-0,3	5.331	1,3	7.170	-0,5
Feb/20	935	5.364.952	5.738	0,0	5.345	1,2	7.158	-0,1
Mar/20	935	5.368.449	5.742	0,0	5.348	1,2	7.158	0,0

Month/ Year	Vínc.	T. Venc. (R\$)	T. Venc. vinc. (μ)	Var. Deflac. (%)	I. Inicial (R\$)	IPCA (%)	Val. Atual. (R\$)	Var. Atual. (%)
May/20	947	5.596.151	5.909	3,6	5.312	1,3	7.418	4,0
Jun/20	956	5.597.546	5.855	-0,9	5.325	1,2	7.331	-1,1
Jul/20	973	5.604.461	5.760	-1,6	5.345	1,2	7.186	-1,9
Aug/20	989	5.605.202	5.668	-1,6	5.357	1,3	7.054	-1,8
Sep/20	1006	5.618.979	5.585	-1,4	5.392	1,2	6.908	-2,0
Oct/20	1036	5.746.483	5.547	-0,6	5.438	1,3	6.801	-1,5
Nov/20	1033	5.876.965	5.689	2,5	5.487	1,2	6.914	1,6
Dec/20	1037	5.784.821	5.578	-1,9	5.561	1,2	6.689	-3,2
Jan/21	1041	5.790.151	5.562	-0,2	5.574	1,2	6.653	-0,5
Feb/21	1040	5.782.518	5.560	0,0	5.622	1,1	6.594	-0,8
Mar/21	1040	5.773.873	5.552	-0,1	5.675	1,1	6.524	-1,0
Apr/21	1041	5.796.925	5.569	0,3	5.692	1,1	6.523	0,0
May/21	1046	5.831.661	5.575	0,1	5.740	1,1	6.477	-0,7
Jun/21	1053	5.860.350	5.565	-0,1	5.770	1,1	6.432	-0,7
Jul/21	1059	5.878.086	5.551	-0,2	5.825	1,2	6.353	-1,2
Aug/21	1061	5.951.969	5.610	1,0	5.876	1,2	6.366	0,1
Sep/21	1063	5.972.868	5.619	0,1	5.944	1,2	6.303	-0,9
Oct/21	1076	6.007.131	5.583	-0,6	6.019	1,1	6.185	-1,8
Nov/21	1073	6.194.552	5.773	3,4	6.076	1,1	6.336	2,4
Dec/21	1104	6.239.377	5.652	-2,1	6.120	1,1	6.158	-2,8
Jan/22	1063	6.231.902	5.863	3,7	6.153	1,0	6.353	3,1
Feb/22	1074	6.251.613	5.821	-0,7	6.215	1,0	6.245	-1,7
Mar/22	1066	6.265.558	5.878	0,9	6.316	1,1	6.205	-0,6
Apr/22	1050	6.261.194	5.963	1,4	6.383	1,0	6.229	0,3
May/22	1057	6.286.145	5.947	-0,2	6.413	1,0	6.184	-0,7
Jun/22	1050	6.287.923	5.989	0,6	6.456	1,0	6.185	0,0
Jul/22	1057	6.345.063	6.003	0,2	6.412	1,1	6.243	0,9
Aug/22	1056	6.385.254	6.047	0,7	6.389	1,1	6.311	1,0
Sep/22	1097	6.591.421	6.009	-0,6	6.370	1,1	6.289	-0,3
Oct/22	1158	6.874.841	5.937	-1,1	6.408	1,0	6.178	-1,7
Nov/22	1209	7.294.419	6.033	1,6	6.434	1,1	6.253	1,2
Dec/22	1227	8.279.769	6.748	11,8	6.474	1,0	6.950	11,1

Legend: Vinc. = Number of Ties/Links (Number of employment contracts or active server registrations); T. Venc. (R\$) = Total Salary/Earnings (Total gross amount received in Brazilian Reais); T. Venc. vinc. (μ) = Average Total Salary per number of ties (Average earnings per employment link); Var. Deflac. (%) = Deflated Variation (Real percentage change, after adjusting for inflation); I. Inicial (R\$) = Initial Index (Starting value or point in Brazilian Reais); IPCA (%) = Consumer Price Index Inflation (Brazil's official inflation measure, *Índice de Preços ao Consumidor Amplo*); Val. Atual. (R\$) = Updated Value (Monetarily corrected value in Brazilian Reais); Var. Atual. (%) = Updated Variation (Percentage change of the value after updating/correction) Source: Developed by the authors based on data made available by SIAPE (Integrated System of Human Resources Administration of the Federal Government) and SIGP (Integrated People Management System) (2023).

The choice of forecasting methods aims to implement more effective actions to obtain more accurate future forecasts, thereby improving personnel allocation. This would allow managers greater visibility into personnel needs to meet organizational demands, as well as

enabling more effective management and monitoring of resources, information, and responsibilities.

The use of these techniques helps better understand variability and model staffing guidelines, minimizing the impact of variations on continuous operations that promote transformations, innovations, and, above all, the improvement of public services offered to society daily.

In the models used, no exact value is defined as acceptable or unacceptable. A comparative analysis of time-series performance is recommended, with testing of various techniques. The methods applied provide accuracy assessment metrics such as RMSE (Root Mean Square Error), MAPE (Mean Absolute Percentage Error), and MAE (Mean Absolute Error), which are fundamental for evaluating forecast accuracy. A lower RMSE indicates greater model accuracy; a value of zero, although rare, suggests perfect forecasts. This model is ideal for comparing different models or for evaluating improvements, although it does not indicate the direction of the errors.

Furthermore, MAPE is used to evaluate the accuracy of performance forecasting models over time, expressed as a percentage. A lower MAPE percentage generally indicates greater forecast accuracy. On the other hand, MAE quantifies the average absolute difference between predicted values and actual values. Its main limitation is the inability to highlight significant errors, which may not adequately reflect the impact of significant deviations. A lower MAE value suggests greater accuracy, while a higher value indicates inferior forecasting performance, without distinguishing between underestimations and overestimations.

4 ANALYSIS OF THE RESULTS

According to the 2019-2022 Management Report, Humap acts as a reference center for the care of patients with infectious and parasitic diseases – infectiology – and, due to these characteristics, its reported data profile predominantly shows diseases such as AIDS, Severe Acute Respiratory Syndrome, and tuberculosis.

In addition to providing care for patients with ischemic stroke, it also stands out as a referral center for high-risk pregnancies, with integration into the following thematic health networks: the Stork Network and the Emergency and Urgent Care Network (RUE), serving as a referral point for adult emergency care and an open-door facility for obstetric and pediatric emergencies (Humap, 2023). Table 9 below illustrates the data on services provided at Humap.

Table 9

Data on services provided

Year	Outpatient Care	Inpatient Admissions	Surgeries	Deliveries	Additional Services ⁶	A.U.E. no PAM	Emergency Room Beds
2015	80.124	8.152	3.069	944	455.578	15.005	–
2016	91.592	8.484	3.232	1.269	505.849	15.995	–
2017	93.623	10.463	4.381	1.670	533.315	17.706	–
2018	94.199	10.905	4.593	1.728	473.338	18.755	–
2019	102.984	11.060	4.954	1.970	47.097	20.631	–
2020 ⁷	41.573	10.000	4.099	1.965	23.678	17.855	–
2021	79.793	9.513	4.002 ⁸	2.093	28.498	11.357	≈ 214
06/2022 a							
06/2023	127.859	11.180	14.226 ⁹	14.226	–	–	≈ 228

Legend: Atend. Amb. = outpatient care; A.U.E. no PAM = Urgent and emergency care at the PAM. Source: Humap (2023).

We observed that managing a university hospital involves complex challenges in prioritizing effective people management and promoting a healthy environment amid the high volume of care provided.

In applied time-series models, there is no single, defined, acceptable, or rejectable value. When analyzing time series performance, it is advisable to test various techniques;

these methods provide evaluation metrics such as RMSE (Root Mean Square Error), MAPE (Mean Absolute Percentage Error), and MAE (Mean Absolute Error).

The lower the RMSE, the greater the accuracy of the predictions. When the value is zero, it indicates that the model perfectly predicts the values (this rarely occurs in practice). The model is ideal for comparing different models or for evaluating improvement; it does not indicate the direction of the error (positive or negative).

Thus, MAPE analysis is also used to evaluate the accuracy of forecasting models of performance over time for time series, expressed as a percentage. The percentage expressed on the scale of the analyzed data shows the average error of the percentage forecasts relative to the actual values, which is useful for comparing or evaluating performance over time. A smaller MAPE generally indicates greater forecast accuracy, expressed as a percentage.

The MAE quantifies the average absolute difference between predicted and actual values. Its disadvantage is that it does not adequately account for significant errors, potentially failing to reflect the impact of huge mistakes. A lower MAE indicates greater model accuracy, while a higher MAE indicates poorer predictive performance. It does not differentiate between underestimation and overestimation errors.

Table 10

Accuracy of methods and combination – Test set – RMSE, MAPE, and MAE for Maturities

ETS	ARIMA	THETA	STL	NNAR	TBATS	Combination
RMSE						
731344.8	532322.6	731344.8	697628.3	938100.4	916080.3	752909.7
MAPE						
7.264081	3.931713	7.264081	7.031115	10.405338	10.230591	7.684605
MAE						
500692.0	281859.1	500692.0	483614.1	706803.4	694256.0	527797.1

Following Hyndman and Athanasopoulos (2018), the choice of the aforementioned methods is to add more effective actions for making future forecasts to improve distribution

with greater precision, in order to give greater visibility to: managers regarding personnel needs to meet demands; managing and monitoring resources, information and responsibilities within an organization; being able to model personnel quantity guidelines so that variations do not affect continuous actions that provide transformations, innovations and, above all, appreciation; and the improvement of public services provided to society daily.

The decision to use the presented models and their combination (Forecast) (Table 10) was intended to project time series and forecast personnel expenditure performance, enabling future projects to consider the analysis in conjunction with the services provided.

First, descriptive statistics were evaluated regarding the number of employment contracts (number of employees) at Humap and the total payroll expenses. It is important to note that values for gross totals, bonuses for performing functions, substitutions, and other factors were not included in the database because a preliminary analysis of these data revealed discrepancies: the amounts include sporadic events that do not apply to all workers. Therefore, for a more accurate understanding, the analysis focused on salaries, the remuneration component common to all, and with the most tremendous financial impact.

After organizing the collected data and specifying the analysis objective, the lowest indices were obtained using the ARIMA modeling technique. The methods, along with the validation, were divided into training and testing phases to preserve the temporal order, which is essential for the model's correct validation. The choice of technique is based on combining the lowest indices presented: RMSE 532322.6; MAPE 3.931713 and MAE 281859.1, to present a more precise predictability that can contribute to the available data and how to delimit these predictions so that they can be weighted according to their relevance, allowing for better management of trends, differences, and even limitations that occur in the care of the assisted population.

Figure 1

Simple Average Combination (Forecast)

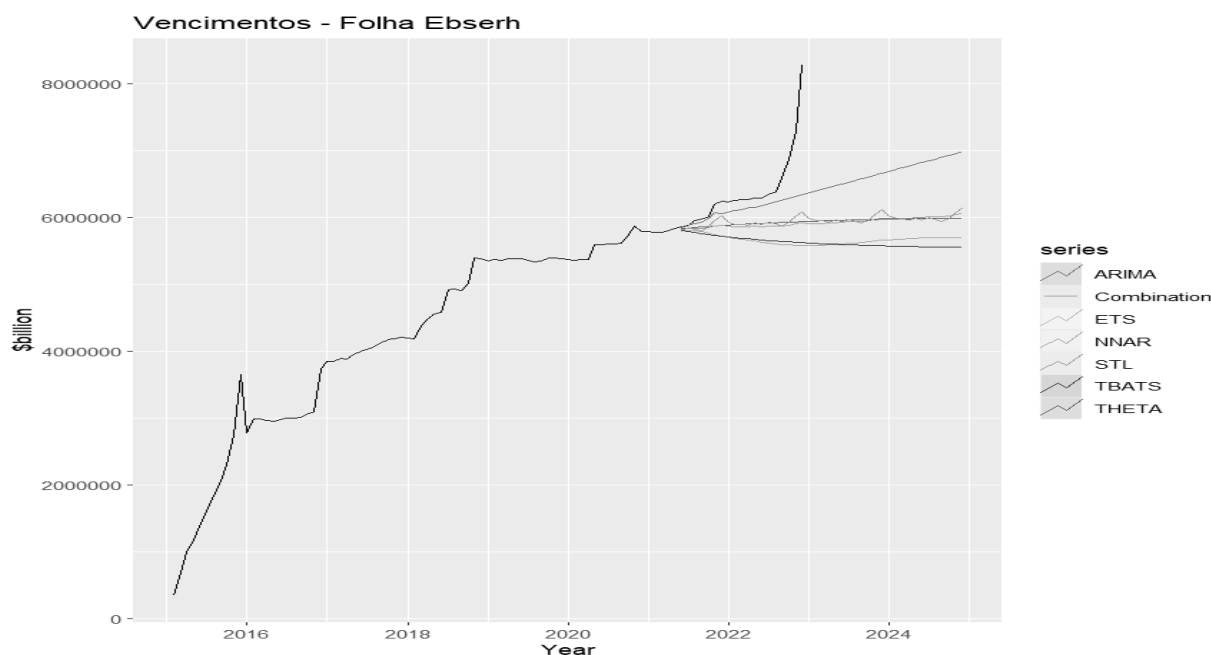


Table 11

Descriptive statistics of total payroll earnings with projection

	With Projection
Average	5509685,781
Standard error	202677,4856
Median	5383423,45
Mode	3849515,88
Standard deviation	2210950,342
Sample variance	4,8883E+12
Interval	9198522,439
Minimum	343337,19
Maximum	9541859,629
Count	119

In the statistical context, the ARIMA technique, based on the database's variability and standard deviation, indicates slight seasonality without regular fluctuations, with a tendency towards stationarity that becomes more evident in the descriptive analysis with projection compared to the analysis without projection (Table 11).

Figure 2

Forecast Future

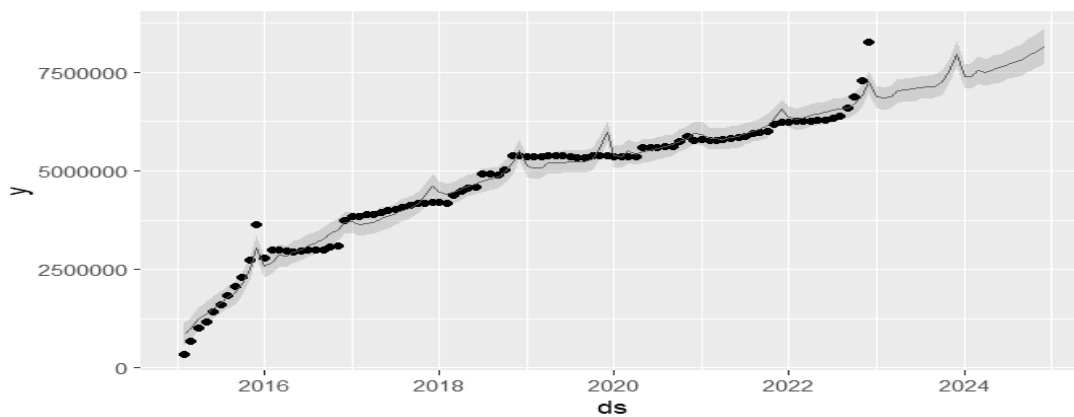
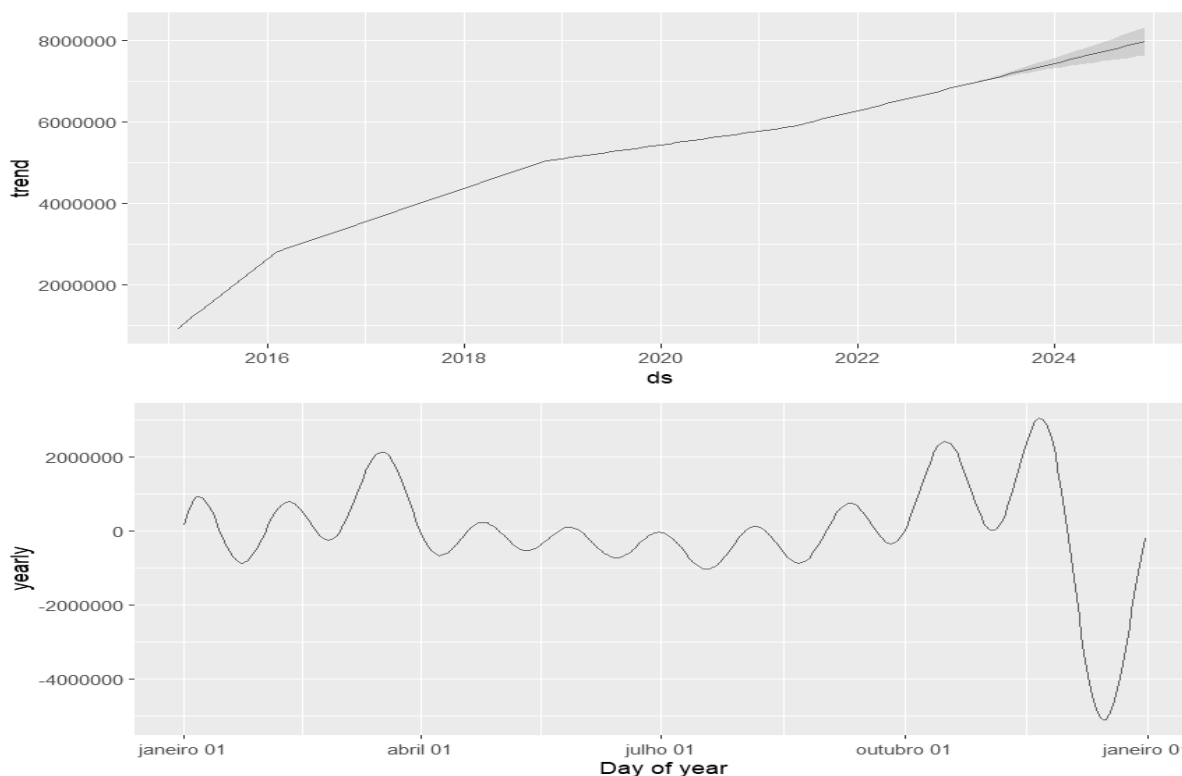


Figure 3

Forecast Future



4.1 Discussion of Results

The analysis of future projections (Figures 2 and 3), whether financial or personnel, requires that the data be based on the organization's historical data for modeling. This allows for anticipating events and trends based on adjusted models of the components of decomposition, seasonality, and trend.

In this way, an initial growth trend was observed; however, at the end of the projection, stagnation is noticeable. One concern is the need to improve the analysis for future planning and potential negotiations to expand the workforce capable of providing the services proposed by the organization.

Table 12

Future Projection, for a period of 24 months – Due Dates

Seq.	ds	Yhat	Yhat lower	Yhat upper
114	2024-07-01	7694083	7330201	8065123
115	2024-08-01	7794974	349979589	8175815
116	2024-09-01	7830050	7433328	8229756
117	2024-10-01	7936401	7535187	8351916
118	2024-11-01	8034760	7623862	8449659
119	2024-12-01	8177736	7701554	8633126

The projection is related to the need for historical data and patterns to address future workforce restructuring. The data indicates that, in December 2024, the total salary will be approximately R\$8,177,736. Considering tables 4 and 5, the average monthly salary for permanent employees is R\$6,612,925. Thus, the forecast establishes an increase of approximately 23.66% in salaries for December 2024.

This means that: i) employees must be more efficient in order to benefit from this increase; ii) there must be an increase in hiring of employees in order to achieve this; iii) some relationship exists between items 1 and 2.

A public policy that relies on personnel expenses must identify service bottlenecks

through a more in-depth analysis—specific job counts and their salaries—to establish the appropriate balance between salary adjustments and workforce hiring.

Table 13

Accuracy of future projection

	ME	RMSE	MAE	MPE	MAPE
Test Set	- 19808.36	284100.3	184589.1	- 0.5943846	2.694331

The model's accuracy decreases in future projections, but this does not appear to affect its quality significantly. However, it should be considered that the reduction indicated by the descriptive statistics (Table 11) may affect the continuity of services provided to the assisted population in the future.

The analysis shows that the personnel expenditure policy at Humap reflects the particularities of a highly complex university hospital, managed by Ebserh and linked to UFMS. The predominance of CLT (Consolidation of Labor Laws) contracts compared to statutory contracts and the use of outsourcing confirm the literature that highlights the need to align people management with organizational strategies, while also revealing difficulties in integration and communication (Silva et al., 2016; Marras, 2016; Porto & Granetto, 2020; Farias & Araújo, 2017).

From a fiscal perspective, the evolution of personnel expenses reinforces the centrality of the Fiscal Responsibility Law as a mechanism for balancing expenditures and revenues (Brazil, 2000), in line with studies that warn of the importance of controlling the growth of the payroll in the public sector (Giuberti, 2005; Rezende et al., 2007).

The complexity of hospital management at Humap is intensified by the high-demand care profile, which aligns with the findings of Santos (2013), Dallora (2007), and Gonçalves and Mascarenhas (2013) on the high costs and management challenges in hospitals. In this

sense, the adoption of cost and human resource management models that promote efficiency and rationalization of resource use is highlighted. The use of forecasting methods aligns with the literature, which points to the need for tools that assist hospital administrators in their resource planning and service quality decisions (Sanz & Sanz, 2022).

More broadly, these results can be understood in light of different organizational theories. As Eldenburg, Xavier, and Krishnan (2017) argue, it is not possible to explain hospital management from a single theoretical approach. In short, the results confirm the challenges highlighted in the literature and advance the process by proposing forecasting tools to support planning, reinforcing the need for public policies that reconcile fiscal requirements with the quality of services provided.

5 CONCLUSIONS

Forecasts of personnel expenditure trends assist decision-making in government negotiations to maintain and expand the organization's workforce and to establish, with greater precision, the criteria and procedures for evaluating performance, efficiency, and the quality of services provided.

The purpose of this proposal is to contribute to the analysis of the dynamics of public policy development on personnel expenditures, using socioeconomic time-series forecasting methods within the scope of HUMAP (Human Capital Assessment Program), and, consequently, to enable the standard definition of a public policy. Regardless of the location or size of the population served, it is possible to highlight the formation of human capital, combined in a balanced way with the distribution of the workforce, a very current topic, but one that organizations constantly face serious problems with.

The next challenge would be studies aimed at estimating and predicting staff replenishment to maintain Humap's healthcare services, harmonized with the needs of the

population served, and used as a standard reference for other hospitals in the network. Future studies may examine the seasonal occurrence of salary adjustments and include local demographic data, linking public payroll policy to the maintenance of service quantity and quality for the population.

The ARIMA, ETS, NNAR, TBATS, and other forecasting models applied in this study serve as tools to support the management of Humap and other public hospitals, allowing the establishment of goals, budget projections, and negotiations for additional resources with the Federal Government using quantitative methods. The ability to anticipate increases or reductions in personnel expenses enables prior planning for hiring, task redistribution, and salary adjustments, reducing the risk of professional overload and service collapse. Furthermore, by providing more accurate forecasts, the study helps ensure that public health policies are tailored to the real needs of the population, thereby maintaining service quality and efficiently using public resources.

From an academic standpoint, we have made progress by exploring the applicability of various time-series models to the analysis of personnel expenditures in the public hospital sector. This field has not yet been addressed in national and international studies. We established a replicable model to monitor and compare time series of expenditures across public institutions, enabling continuous monitoring and adaptability across different contexts. The results reveal how variations in staffing levels and salaries relate to trends in demand for health services, providing a basis for studies that integrate financial, demographic, and epidemiological data.

Finally, it opens the door to future investigations that compare the accuracy of different predictive models across hospitals of varying scales, regions, and management regimes, incorporate treatments for extraordinary events, such as the COVID-19 pandemic, and propose specific adaptations for the university hospital context. We suggest conducting

qualitative interviews with managers to understand hiring decision-making processes and the non-quantifiable factors that influence personnel costs. Furthermore, we suggest that future research focus on the effectiveness of different strategies for optimizing hospital human resources and their implications for the quality of care.

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NOTES

1. Activity-Based Costing (ABC) is a method that assigns costs to products based on the activities that consume resources, providing greater accuracy in profitability analysis.
2. RJU – The Legal Regime of Public Servants of Brazil is the title regulated by Law No. 8,112 of 1990, intended to regulate the career of public servants; CLT – Consolidation of Labor Laws is the document that regulates labor relations in the country and the rights of workers, Decree-Law No. 5,452, of May 1, 1943.
3. DDP – Personnel Expense Statement.
4. SIAPE – Integrated Personnel Administration System.
5. SIGP – Personnel Management Information System
6. Ultrasound, urology, dermatology, hemodynamics, echocardiogram, ophthalmology, etc.
7. Beginning of the Covid-19 pandemic.
8. Estimate.
9. Obstetric Emergency Room

LIST OF ABBREVIATIONS AND ACRONYMS

PHC	Primary Health Care
ARIMA	Autoregressive Integrated Moving Averages
AR	Autoregression
CLT	Consolidation of Labor Laws
CNES	National Registry of Health Establishments
DDP	Personnel Expense Statement
DIVGP	Human Resources Management Division
EBSERH	Brazilian Hospital Services Company
EMV	Maximum Likelihood Estimate
ETS	Error, Trend, and Seasonality
HUMAP	Hospital Maria Aparecida Pedrossian
IBGE	Brazilian Institute of Geography and Statistics
I	Integration
IPCA	Consumer Price Index
MA	Moving Average
MAPE	Average - Absolute Percentage of Error
BRL	Brazilian Reais
RJU	Single Legal Regime
RMSE	Root Mean Square Simulation Error

SERPRO	Federal Data Processing Service
SIAFI	Integrated Financial Administration System of the Federal Government
SIAPE	Integrated Human Resources Management System
SIDRA	IBGE Automatic Recovery System
SIGP Menthor	Menthor Personnel Management Information System
SIPEC	Civil Personnel System of the Federal Administration
SUS	Unified Health System
ST	Seasonality - Trend
TG	Treasury Management
UFMS	Federal University of Mato Grosso do Sul

Tendências de Gastos com Pessoal do Hospital Maria Aparecida Pedrossian: Previsão com Séries Temporais

RESUMO

Objetivo: Analisar a tendência dos gastos de pessoal do Hospital Maria Aparecida Pedrossian (Humap) e fazer previsões, com recorte de 2015 a 2022.

Método: O método foi quantitativo, com dados temporais, baseado na combinação de métodos estatísticos de previsão (ETS, Theta, ARIMA, NNAR, TBATS e STL).


Originalidade/Relevância: Demonstra a possibilidade dos gestores projetarem novas contratações com base nos padrões observados nos dados históricos, a fim de medir a variabilidade dos gastos de pessoal.

Resultados: Obteve-se um modelo de previsão do desempenho com base nos gastos de pessoal do Humap, a fim de subsidiar políticas públicas na área de pessoal.

Contribuições Teóricas/Metodológicas: Apresentam um modelo de políticas públicas de gestão de pessoas baseado nos gastos de pessoal.

Contribuições Sociais/para a Gestão: Apresenta a possibilidade de modelar as diretrizes de quantidade de pessoal, para que essas variações não afetem as ações contínuas que promovem melhorias nos serviços públicos prestados à sociedade.

Palavras-Chave: Desempenho, Gastos de Pessoal, Políticas Públicas.

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