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Medium-Term Capacity Planning in Servuccion Systems: Case Study specialized Outpatient Medical Services

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Abstract

One of the great problems faced by organizations worldwide is how to guarantee sufficient production capacity to be able to respond efficiently, effectively and effectively to the demands of the different social interest groups that benefit from the supply of goods and / or services manufactured by them. Understood capacity as the rate of production that is expected to be achieved and defined this variable with the main responsible for organizations remaining in force within the productive context, since what is not produced is not sold. Taking into account the above, it is necessary to operationalize in organizations, methodologies that allow in the long, medium and short term to define in advance the behavior of production capacity and thus prepare organizations to face the high levels of variability faced by companies in terms of market behavior. Thus, in the present work we develop a process of planning the Capacity of Servuccion in the medium term in an organization of specialized medical services (Outpatient Consultation), based on the aggregate planning of production and operations, also known as sales and operations planning, in which from the development and / or analysis of pure and combined strategies supported in heuristic techniques developed, it is intended to help organizations with similar characteristics, within the economic context where they operate, have sufficient resources, capable of responding to such demands at the lowest possible cost.

Keywords

Servuccion, Outpatient Consultation, Servuccion Capacity, Aggregate Planning.

1. Introduction

When we talk about Servuccion, we refer to systems of manufacture of services of very high complexity where there is usually direct interaction of the client, his need and the production process through the human agent or personal contact, as it happens in the processes of external consultation, in which the doctor specialist patient relationship determines the success of the act of production of health services (Garzon Saenz & Redchuk , 2021).

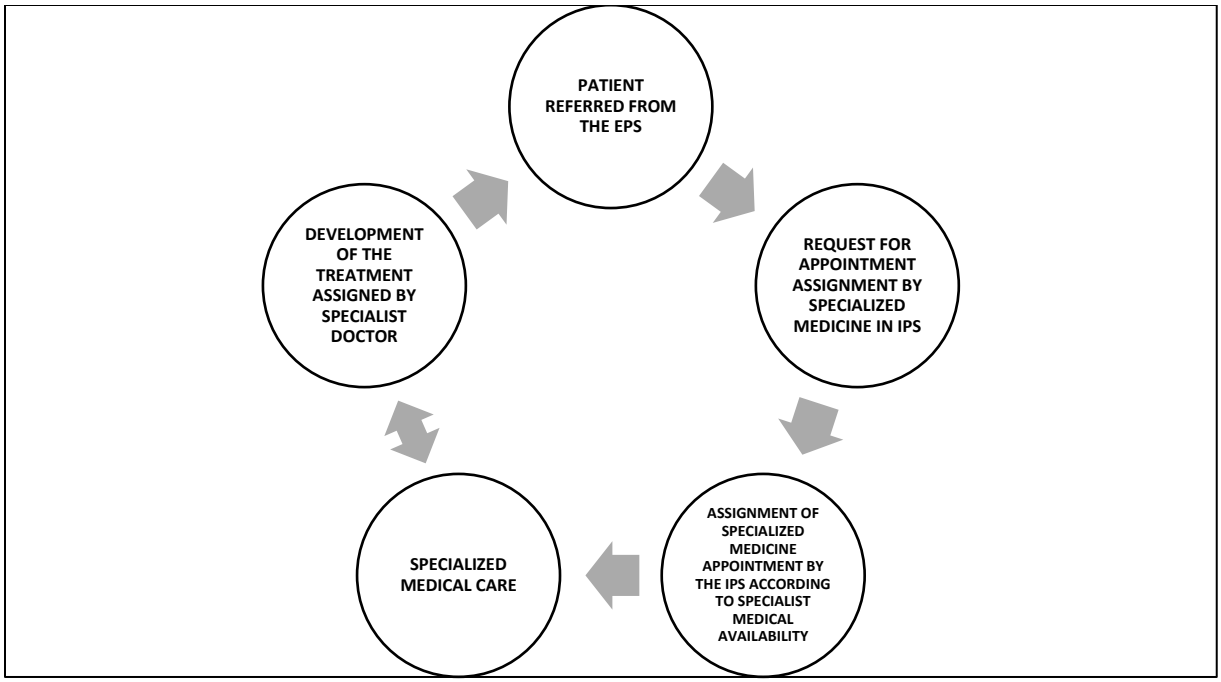

Figure 1. Cycle of Specialized Medical Services Care.

As can be seen in Figure 1, called the Specialized Medical Services care cycle or outpatient consultation, these services are normally developed by an entity that provides such services, as long as they are duly authorized (Ministerio de Salud y Proteccion Social, 2019) and which is called in Colombia IPS (Institution Providing Health Services) through contracting with an EPS (Health Promoting Entity) who would be the direct client and in turn is the guarantor of the adequate execution of these services (Ministerio de Salud y Protección Social, 2014), which must be developed within the framework of the National Policy for the Provision of Health Services, which is proposed and developed around three fundamental axes: accessibility, quality and efficiency of health services in Colombia (Ministerio de la Protección Social, 2005).

The manufacture of outpatient services refers to a series of medical specialties that are developed in organizations called Health Provider Institutions (IPS), which must be authorized by the general health system in order to complement, strengthen and generate this offer, this authorization requires these health care centers to comply and respond to the requirements established by the Mandatory System of Quality Assurance of Care In the case of Colombia, it establishes a set of institutions, standards, requirements, mechanisms and deliberate and systematic processes to generate, maintain and improve the quality of health services in the country. From this point of view there are several indicators that are of interest to the health system, but for the present work only focuses the objective on two of them, which are: the opportunity and accessibility to the service, indices that seek to encourage improvement actions that increase the possibility of the user to obtain the services he requires, without delays that put their lives or health at risk, reduce failures related to the organization of the supply of services in relation to demand, and with the level of institutional coordination to manage access to services. These indicators have been considered very critical since according to a report generated by the World Bank 2019, in its study called External Assessment of Quality of Care in the Health Sector in Colombia, it establishes that waiting times are still comparable to those of many high-income countries, but they have increased for different medical specialties and remain a worrying problem. Average wait times have seen a moderate increase from 2011 to 2018, for example, for general practitioners (from 2.7 to 3.4 days) and gynecology consultations (2.7 to 10.1). Waiting times for pediatric consultations were 8.8 days, for internal medicine 12 days. Among 5 of the 19 OECD countries that contributed data, at least half of the residents waited four or more weeks to see a specialist, suggesting an average waiting time of at least one month, which is not unrelated to the case study selected for this proposal where the opportunity in the allocation of specialized medicine appointments is between 45 and 60 days, which at present and given the times of pandemic has been mostly impacted (The World Bank Group, 2019).

Within this framework, the Health Promotion Entities must guarantee the health status of the population through the development of promotion and prevention programs, among others. Patients duly affiliated to the health system, either by subsidized or contributory regime, come to these entities who, based on an assessment by general medicine, internal medicine among other specialties, refer to Institutions Providing Health Services which, in order to guarantee the coverage of health services and guarantee the axes formulated by the national health services policy, complement the work of the EPS by offering specialized medical services which largely depend on the availability of medical specialists. Becoming this aspect in the central axis of this work, in which through capacity planning tools it is intended to establish the most appropriate mechanism to guarantee the availability of specialist doctors in sufficient quantity in such a way that the opportunity in the health service offered by the institution providing health services under study is favored.

Given the elements described above and especially what is established by the SOGCS, the OPPORTUNITY aspect is established in this work as a fundamental axis of action, for which the following question arises:

How to guarantee the efficiency of Health Services through the guarantee of offering timely health services that promote the permanent availability of the service, without any delay?

1.1 Objectives

- Analyze the behavior of sales of specialized medical services in an aggregated manner through quantitative forecasting techniques with a view to estimating future sales of such services.
- Establish the capacity needs of specialized medical services with a view to establishing mechanisms to guarantee the availability of such services.
- Develop pure and combined medium-term capacity planning strategies to establish the best alternative in terms of capacity to ensure the availability of specialized medical services at the lowest possible cost.

2. Literature Review

2.1. The Servuccion System

When we talk about Servuccion (manufacture of services), it is very important to establish mechanisms that allow standardizing processes in order to guarantee the necessary resources to manufacture quality and highly productive services. The service refers to those manufacturing systems of very high complexity framed in most cases in the classification of production systems by project since it is to satisfy particular needs, not standardized of customers from various sectors of the market as is the case of the health sector, where the standardization of processes is difficult because although the symptomatology of a disease is the same the cause that the generation is different therefore the way to face this symptomatology is different (Garzón Saenz, Solana Garzón, & Ortiz Piedrahita, 2017).

Servuccion is a French term proposed by the French professors Pierre Eiglier and Eric Langeard, to designate the process of manufacturing a service in an equivalent way to production that is how the process of making a tangible good is traditionally called. Servuccion is the systematic and coherent organization of all the physical and human elements of the client-company relationship necessary for the realization of the provision of a service whose commercial characteristics and quality levels have been determined (Eiglier & Langeard, 1989). So, in the same way that to manufacture a good requires a production system that develops in a logical, orderly and sequential way tasks in which labor, machines, raw materials interact with the help of a method or procedure in a previously defined environment until obtaining the finished product and finally through a distribution and marketing system make it available to a market. For the manufacture of services requires the interaction of three components such as the contact personnel, the physical agent and the customer at a time that unlike the manufacture of goods there is no new opportunity to repeat and is what is called moment of truth (Serna Gomez, 2015), in which all the necessary conditions must be generated to guarantee the customer a truly incomparable experience (Pereira Calvo, 2014).

2.2. Servuccion Capacity

The capacity of Servuccion is defined, as the rate of manufactured services that is expected to be reached, in the case of a health service provider entity, it will be defined as the number of patients expected to be treated, this number of patients attended will depend on factors such as the availability of personnel for care, the location of the facilities, the behavior of sales, among others and this must be carefully established in such a way as to guarantee a true customer experience since the services are manufactured and offered in situ and face to face with the client but in the health

services which does not give rise to improvisations or reprocesses so it is required to have the necessary resources in the moment that the client requests it in such a way that an immediate response is given to said requirement. Planning for capacity levels in services should take into account the day-to-day relationship between service utilization and quality (Chases & Jacobs, 2014).

2.3. Aggregate Planning

Also known as sales and operations planning and for the case of this work called medium-term capacity planning, since it is a set of techniques and / or strategies, which allow to visualize the best way to meet the capacity requirements of a production system and / or Servuccion in terms of costs and aligned to organizational policies and strategies through the conversion of a production system and/or heterogeneous servuction (that is, it manufactures multiple products and/or services), in a homogeneous system (that is, it manufactures a single product) through aggregation, unification through a common factor that in methodological development is defined as an aggregate unit, which allows unifying the diversity of demands that a productive context may have and thus facilitate its analysis and planning. (Rahmer, Garzón Saenz, & Garzón Solana, 2022).

In general, for the development of this technique, three methods are usually developed, thus, leveling method, which establishes a certain level of resources, which implies that demand will fluctuate around its availability or, failing that, attempts will be made to alter demand patterns so that they adjust more effectively to the established resources. Tracking method, it does not seek to alter demand, but resources. In fact, in a "pure" monitoring environment, resources are continuously increased or reduced, adjusting to a demand that fluctuates under normal market conditions. As the name implies, companies that use this method "mix and adjust," altering demand and resources in ways that maximize performance according to their established criteria, which include profits, investment in inventories, and impact on people. (Chapman, 2006).

3. Methods

The type of research that was used for the development of this work is framed in applied research since it is about applying and adapting concepts such as medium-term capacity planning in non-traditional contexts such as case study servuction systems specialized medical services or outpatient and quantitative research since for the development of the proposed objectives will be Use of quantitative information derived from the operation of the selected context under study.

Likewise, the project will be developed within the framework of the following activities, as follows in Figure 2:

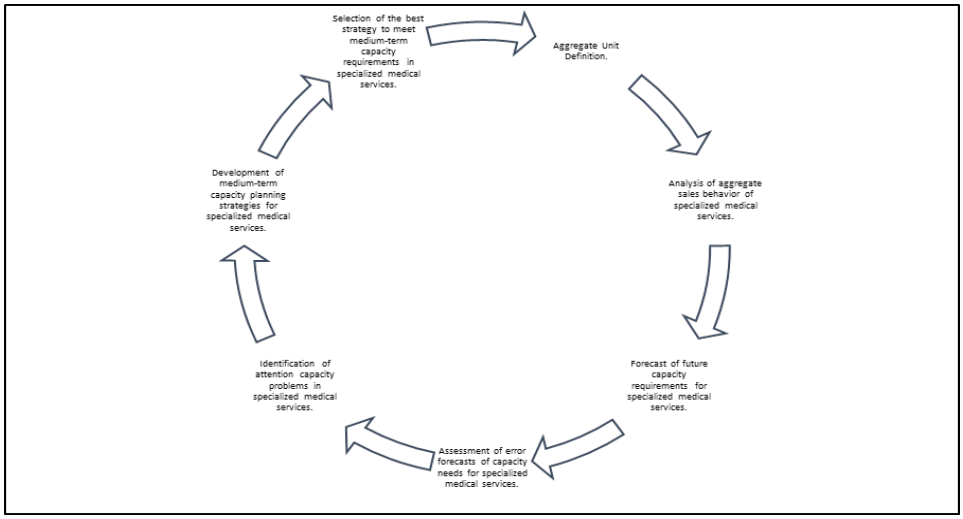

Figure 2. Methodological design of the Research

3. Characterization of the External Consultation process.

Through the characterization it is intended to show the behavior of some indicators, associated with the management of operations of the external consultation process and especially in the quality perspective, which must be reported to the control entities periodically as established by the information system for quality established by the Mandatory System for Quality in the Health Sector, the indicators are (Table 1):

Table 1. Quarterly behavior of the Global Satisfaction Index of the Users of the External Consultation Service Studied

INDICATOR NAME	**Overall Satisfaction Ratio 2020 - 2021**				**GOAL 2020**	**≥80%**	**GOAL 2021**	**≥90%**
BIMONTHLY / QUARTER	**JAN - FEB/2020**	**MAR - APR/2020**	**MAY - JUN/2020**	**JUL - AUG/2020**	**SEPT - OCT/2020**	**NOV - DEC/2020**	**JAN - MAR/2021**	**APR - JUN/2021**
Number of affiliates and users who consider themselves satisfied with the services received in the IPS	243	229	204	215	214	257	248	761
Total number of affiliates surveyed by the IPS.	284	257	248	255	263	288	270	826
Overall satisfaction ratio.	86%	89%	82%	84%	81%	89%	92%	92%
MEANING OF THE INDICATOR	**The monitoring of this indicator will allow to identify the level of satisfaction of the users with the services and treatment received by the institution providing health services.**							

As described in Table 1, which shows the results of the indicator called proportion of the degree of global satisfaction for the period between 2020 and 2021, where for 2020 the indicator was measured with a bimonthly frequency and with a goal greater than or equal to 80% satisfaction and for 2021 a quarterly measurement was established and with a goal greater than 90%, a positive behavior is observed for the aforementioned period where 100% of the measurements show compliance above the proposed goals but 100% satisfaction is never obtained in terms of the services and treatment received by the users of the different specialties offered in the Institution Providing Health Services (Garzon Saenz & Redchuk , 2021).

Table 2. Cumulative Behavior of the Appointment Opportunity Index by Specialty for the Outpatient Service Studied

INDICATOR NAME	Opportunity for appointments by specialty 2021			GENERAL GOAL SPECIALTIES	<=30 days	PEDIATRICS GOAL	<=5 days
SPECIALITY	ALLERGOLOGY	DERMATOLOGY	PHYSIOTHERAPY	PHYSIOTHERAPY	ADULT PULMONOLOGY	OTOLARYNGOLOGY	PEDIATRICS
Total sum of the calendar days elapsed between the date on	159423	6824	1856	28405	55803	8455	1959

which the patient requests an appointment to be treated at the specialized medical consultation and the date for which the appointment is assigned.							
Total number of specialized medical consultations assigned in the institution.	5120	645	431	1184	2254	494	418
Appointment opportunity days by specialty.	31	11	4	24	25	17	5
MEANING OF THE INDICATOR	The monitoring of this indicator will allow to identify the opportunity of appointments by specialty in the institution						

Table 2 describes the behavior of the appointment opportunity indicator by specialty for the outpatient service, for which the following analysis considerations are established: the established values are accumulated values for the first 6 months of the year 2021, a goal is established for general specialties such as Allergology; Dermatology; Physiotherapy; Adult Pulmonology; Otolaryngology that should be less than or ideal at 30 days and for Pediatric specialties such as Pediatric Pneumology and Pediatrics in which the goal must be less than or equal to 5 days, it is observed that the highest rates of attention are in the specialties of Allergology; Adult Pulmonology and Pediatric Pulmonology, of which the specialty of Allergology is critical in the opportunity indicator with an average of 31 days to assign an appointment, followed very closely by the specialties of Adult and Pediatric Pneumology the latter evidencing a high degree of criticality since it would be analyzed from the specialty of Pediatrics where the goal is less than 5 days to assign the appointment, Likewise, there is an opportunity for improvement in the specialty of Pediatrics where on average the goal is achieved but without opportunity to vary above the established limit because the defined Indicator would be in non-compliance (Garzon Saenz & Redchuk , 2021).

In addition to the previous data where the behavior of two important indicators such as the Overall Satisfaction Ratio 2020 – 2021 and the Opportunity for appointments by specialty 2021 is evidenced, it is necessary to achieve the objective proposed by this work to establish the historical behavior of sales of the specialized medical services of the health organization under study, For which in Table 3, this history corresponding to the years 2020, 2021 and 2022 is described and where the behavior of the specialties that generate 90% of the organization's income is indicated, as follows:

Table 3. Historical performance of sales of specialized medical services

HISTORY OF SPECIALIZED MEDICAL SERVICES YEARS 2020 - 2022													
YEAR	SPECIALITY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
2020	ALLERGOLOGY	1074	1025	682	458	552	602	593	687	790	705	754	633
	DERMATOLOGY	286	319	158	39	96	83	100	86	115	44	95	82
	PHYSIOTHERAPY	69	28	32	0	0	0	0	6	14	16	61	63

	PNEUMOLOGY	739	717	504	342	296	294	297	367	465	447	398	406
	OTORHINOLARYGOLOGY	44	110	88	46	63	89	85	102	139	44	45	45
	PEDIATRICS	145	170	108	61	62	33	80	69	89	10	71	75
	SOMOLOGY	35	26	17	0	1	5	20	22	13	17	20	19
YEAR	SPECIALITY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
2021	ALLERGOLOGY	547	815	982	879	912	950	1064	1096	1360	1237	1270	1137
	DERMATOLOGY	111	93	127	88	109	109	103	122	134	165	157	97
	PHYSIOTHERAPY	26	69	71	72	111	83	110	135	102	93	95	75
	PNEUMOLOGY	343	602	701	606	576	582	625	658	637	560	581	453
	OTORHINOLARYGOLOGY	54	106	80	85	75	92	64	95	33	67	131	73
	PEDIATRICS	53	79	78	72	62	63	65	66	64	64	41	36
	SOMOLOGY	9	14	41	37	46	37	45	45	50	40	44	34
YEAR	SPECIALITY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
2022	ALLERGOLOGY	1060	1216	1606	1408	1617	1773	1800	1890	1915	1945	1956	1867
	DERMATOLOGY	140	184	193	155	178	185	189	194	198	200	189	183
	PHYSIOTHERAPY	31	30	45	32	41	43	45	47	49	52	54	48
	PNEUMOLOGY	329	539	559	521	759	794	878	963	980	996	1025	990
	OTORHINOLARYGOLOGY	92	101	90	95	85	87	85	83	81	79	75	72
	PEDIATRICS	0	28	23	35	30	44	50	57	64	70	77	70
	SOMOLOGY	40	45	51	48	47	52	53	55	57	59	60	55

In addition to the historical sales behavior, it is necessary to determine some variables that will serve as parameters to develop the respective analyses and the planning of medium-term capacity in the Servuccion system under study, these can be seen in Table 4:

Table 4. restrictive variables

COST INFORMATION		
ITEM	**QUANTITY**	**UNIT**
MEDICAL SUPPLIES	20	US$/PACIENTE
COST PER INVENTORY	0	US$/PACIENTE/MES
COST FOR MISSING	25	US$/PACIENTE/MES
COSTS FOR SELECTION AND TRAINING	250	US$/MEDICO
COST OF FIRING	1100	US$/MEDICO
UNIT ATTENTION TIME	0,1	HRS/PACIENTE
NORMAL HOUR COST	50	US$/HR
EXTRA HOURLY COST	62,5	US$/HR
INITIAL INVENTORY	0	PACIENTE
PRODUCTIVE TIME	7	HR- H/DIA
PAID HOURS PER DAY	8	HR/DIA
ENTRY-LEVEL WORKFORCE	21	MEDICOS
COST FOR OUTSOURCING	50	US$/PACIENTE
REPRESENTATIVE RATE OF THE DOLLAR IN COLOMBIA	4810	$/US$

5. Results and Discussion

5.1 Analysis of the behavior of sales of Specialized Medical Services.

En aras de desarrollar el trabajo planteado, se hace necesario analizar el comportamiento histórico de las ventas de servicios médicos especializados en la organización objeto de estudio con miras a proyectar los doce meses del año 2023, para lo cual se desarrollaron las siguientes etapas obteniéndose los siguientes resultados:

5.1.1. Aggregate Unit Definition

This stage basically consists of converting a heterogeneous system, that is, a productive system that is capable of producing multiple products into a system that produces a single product from the definition of a common factor that allows unifying all the demands into one, for which the following question was raised: WHAT DOES THE ORGANIZATION SELL? From this it was established that the organization sells specialized medical services to patients who present a symptomatology or pathology, therefore it was determined that the common factor was the PATIENT concept, so we proceeded to add arithmetically the number of patients of each specialty and for each month, obtaining the following result (see Table 5):

Table 5. Aggregate actual sales

PERIOD	X	AGGREGATE ACTUAL SALES
JAN	1	5227
FEB	2	6316
MAR	3	6236
APR	4	5079
MAY	5	5718
JUN	6	6000
JUL	7	6351
AUG	8	6845
SEP	9	7349
OCT	10	6910
NOV	11	7199
DEC	12	6513

5.1.2. Analysis Of Aggregate Sales Behavior of Specialized Medical Services

Una vez definidas las ventas históricas de manera agregada, se realizó un analisis del comportamiento de estas, entendiendo que la agregación disminuye los niveles de variabilidad que se presentan en comportamientos de ventas de productos individuales y específicos.

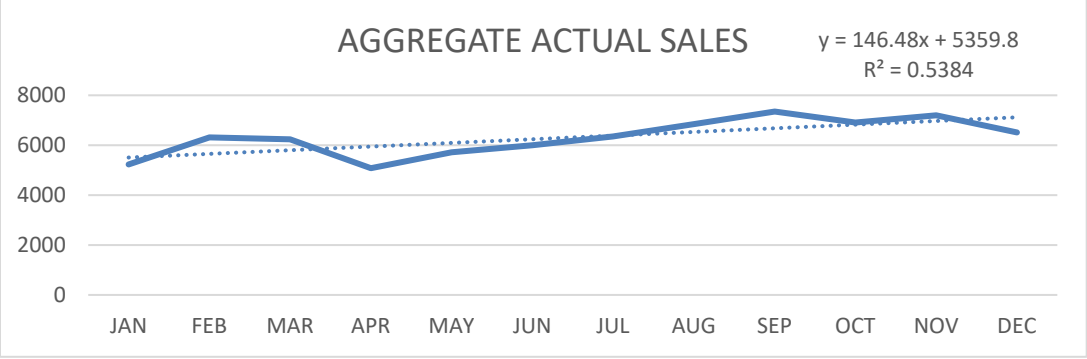

Figure 3. Behavior of actual aggregate sales

As shown in Figure 3, the behavior of aggregate real sales, shows a low level of noise or dispersion or variability, which means that no seasonal or cyclical behavior is observed, it tends to be stable which can translate into a high probability of being predictable, so it is decided to make use of a technique such as linear regression to predict the requirements of capacity for the period 2023.

Thus, using Excel and the regression function, the following results are obtained (See Table 6):

Table 6. Regression Statistics

Regression Statistics	
Multiple correlation coefficient	0,73372787
Coefficient of determination R^2	0,538356587
R^2 tight	0,492192246
Typical error	512,9343139
Remarks	12

The results observed in Table 6 do not show that the technique used is reliable, which allows us to predict quite accurately the capacity requirements of the year 2023 by applying the equation in a straight line that has the form:

$$\boldsymbol{y = a + bx}$$

Where:

y=Forecasted Demand (in number of patients per month)
x= time (months, which will be coded from 1 to 12)
a= Independent variable
b = the slope (which shows us that there is a trend towards growth in the number of patients treated)

By making use of the Excel regression function, the following straight-line equation is obtained that allowed us to project the capacity requirements of the year 2023:

$$\boldsymbol{y = 5359,8 + 146x}$$

From the application of the linear regression model, the following results are obtained (see Table 7):

Table 7. Forecast of required capacity for 2023

Period (x)	Aggregate actual sales (y)	Y=5359,8+146,48X	X	Forecast	ERROR	ABS	MAD	TS
1	5227	5506,28	13	7264,04	-279,28	279,28	279,28	-1
2	6316	5652,76	14	7410,52	663,24	663,24	471,26	1
3	6236	5799,24	15	7557	436,76	436,76	459,76	2
4	5079	5945,72	16	7703,48	-866,72	866,72	561,5	0
5	5718	6092,2	17	7849,96	-374,2	374,2	524,04	-1
6	6000	6238,68	18	7996,44	-238,68	238,68	476,48	-1
7	6351	6385,16	19	8142,92	-34,16	34,16	413,291429	-2
8	6845	6531,64	20	8289,4	313,36	313,36	400,8	-1
9	7349	6678,12	21	8435,88	670,88	670,88	430,808889	1
10	6910	6824,6	22	8582,36	85,4	85,4	396,268	1
11	7199	6971,08	23	8728,84	227,92	227,92	380,963636	2
12	6513	7117,56	24	8875,32	-604,56	604,56	399,596667	0

From the behavior of the tracking signal, it can be established that there is a probability of between 60 and 89% that the data projected from the linear regression technique are fulfilled as can be observed oscillate the results of the tracking signal between values of +/- 1 to +/-2, with only two values outside the normal limits.

5.2 Establishment of capacity needs for Servuccion of Specialized Medical Services

Once the capacity requirements were projected, we proceeded to establish whether or not there would be capacity problems for the year 2023, for which the required capacity was compared against the available capacity from the scenario that only one specialist doctor was available, obtaining the following results (see Table 8):

Table 8. Capacity Analysis Scenario 2

CAPACITY ANALYSIS												
MONTH	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
REQUIRED CAPACITY	**5227**	6316	**5227**	6316	**5227**	6316	**5227**	6316	**5227**	6316	**5227**	6316
DAYS AVAILABLE PER MONTH	**25**	24	26	22	25	24	24	25	26	25	21	23
HOURS AVAILABLE PER MAN PER MONTH	175	168	182	154	175	168	168	175	182	175	147	161
AVAILABLE CAPACITY	1750	1680	1820	1540	1750	1680	1680	1750	1820	1750	1470	1610
HOURS PAID PER MAN PER MONTH	200	192	208	176	200	192	192	200	208	200	168	184
SALARY MONTH WORKER	10000	9600	10400	8800	10000	9600	9600	10000	10400	10000	8400	9200
LEFTOVER (+) /MISSING (-)	**-3477**	**-4636**	**-3407**	**-4776**	**-3477**	**-4636**	**-3547**	**-4566**	**-3407**	**-4566**	**-3757**	**-4706**

As can be seen in Table 8, a specialist doctor is not enough to meet the capacity requirements, given the variety of specialized medical services, a greater number of doctors is required, which is clearly observed in the IPS studied, which showed a total of 21 specialist doctors, ready for the attention of the different specialties, which denotes that if the available time were used in a better way, the entity would have excess capacity and very surely the indicators of satisfaction and opportunity would improve substantially(See Table 9).

Table 9. Capacity Analysis Scenario 2

CAPACITY ANALYSIS												
MONTH	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
REQUIRED CAPACITY	**5227**	6316	**5227**	6316	**5227**	6316	**5227**	6316	**5227**	6316	**5227**	6316
DAYS AVAILABLE PER MONTH	**25**	24	26	22	25	24	24	25	26	25	21	23
HOURS AVAILABLE PER MAN PER MONTH	3675	3528	3822	3234	3675	3528	3528	3675	3822	3675	3087	3381
AVAILABLE CAPACITY	36750	35280	38220	32340	36750	35280	35280	36750	38220	36750	30870	33810
HOURS PAID PER MAN PER MONTH	200	192	208	176	200	192	192	200	208	200	168	184
SALARY MONTH WORKER	10000	9600	10400	8800	10000	9600	9600	10000	10400	10000	8400	9200
LEFTOVER(+)/MISSING(-)	**31523**	**28964**	**32993**	**26024**	**31523**	**28964**	**30053**	**30434**	**32993**	**30434**	**25643**	**27494**

Table 9 shows scenario 2 of the capacity analysis where the calculations were based on the assumption that the 21 available specialists worked the available calendar days per month, in this scenario it is clearly established that making use of the maximum available capacity there would be excess care capacity, which would clearly lead to a decrease in specialist medical personnel.

5.3 Development of pure and combined strategies for medium-term capacity planning of Specialized Medical Services.

Once the capacity analysis has been developed and under the premise of scenario 1 described in table 8, we proceed from the Excel spreadsheet to develop pure aggregate planning strategies to analyze new scenarios that allow the organization to better manage its Servuccion model in order to comply with the approach established in the national health services policy, which refer to offering quality, efficient and accessible services, describing the following results:

5.3.1. Demand fluctuation strategy (Dismissal and hiring)

Table 10. Demand fluctuation strategy (persecution or dismissal and engagement)

DEMAND FLUCTUATION STRATEGY (PERSECUTION OR DISMISSAL AND ENGAGEMENT)													
MONTH	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
REQUIRED CAPACITY	5227	6316	5227	6316	5227	6316	5227	6316	5227	6316	5227	6316	
INITIAL INVENTORY	0	0	0	0	0	0	0	0	0	0	0	0	
REQUIRED PRODUCTION	5227	6316	5227	6316	5227	6316	5227	6316	5227	6316	5227	6316	
MEN REQUIRED	3	4	3	4	3	4	3	4	3	4	4	4	
HIRE(+)/DISMISS(-)	-18	1	-1	1	-1	1	-1	0	-1	1	0	0	
WORKFORCE	3	4	3	4	3	4	3	4	3	4	4	4	
FINAL INVENTORY	0	0	0	0	0	0	0	0	0	0	0	0	
COSTS OF THE DEMAND FLUCTUATION STRATEGY													**SUBTOTAL**
PAYROLL COST	29868,57143	36091,42857	29868,57143	36091,42857	29868,57143	36091,42857	29868,57143	36091,42857	29868,57143	36091,42857	29868,57143	36091,42857	$ 197.880
COST OF HIRING		193,1666667		307,3301698		193,1666667				184,2912088			$ 694
COST OF FIRING	19814,45714		976,3003663		1225,885714		713,0357143		810,8813187				$ 22.017
TOTALCOST	**$ 220.590**												

Table 10 describes the results of the pure strategy of fluctuation of demand which consists of making available capacity more flexible according to the fluctuation of the required capacity, in order to calculate exactly the level of capacity that is required at the moment to not produce neither more nor less therefore it is a strategy that does not admit neither surpluses nor shortages, since staff is hired or fired in this case depending on fluctuations in the required capacity. A partir de esto se observa que esta estrategia cumple la misiva estableciéndose la necesidad de despedir 18 médicos en el primer periodo y a partir de ahí se observa como de manera fluctuante se contrata 1 en un periodo y se despide al periodo siguiente observándose tambien que en los meses de noviembre y diciembre no se hace necesario contratar ni despedir médicos puesto que con 1 que se contrató en el mes de octubre es sufiente para los de diciembre y octubre del 2023, asi como tambien, ademas se observa que la estrategia tiene un costo total de US$ 220.000 dólares americanos

Given the characteristics of the organization, it was not necessary to develop the strategies of INVENTORY FLOW STRATEGY, because it is an Institution providing Health Services, it is impossible to store patients with symptoms and / or pathology, by law and by universal right must fulfill its mission almost immediately; SUB-TREATMENT STRATEGY, in this case it was not necessary to develop this strategy since it is the only entity that provides the aforementioned health services and there is no entity as such that offers the same as it, as well as the strategies of OVERTIME STRATEGY, this was not necessary either since by own policies and availability of medical personnel it is impossible to work overtime and COMBINED STRATEGIES and in this case because The strategy of fluctuating demand speaks for itself It is not necessary to combine these to see how the quality and timeliness of the Outpatient Service is improved.

6. Conclusion

Through the development of this work, it can be concluded that:

- In the case of health services, it could be said that they behave deterministically, since their daily production process has the clarity of how many patients they will attend, which allows them to somehow observe some stability in terms of sales behavior and this in turn allows the use of linear regression techniques as observed in the case study and especially in the context of the external consultation, with the certainty of obtaining successful results that allow for adequate capacity planning.
- As for capacity analysis, it is impossible for the organization to develop a process with a single medical specialist. Since the offer characteristics defined by the IPS require a wide variety of specialists as of today, 21 are available.
- It should be noted that from the strategy of fluctuation of demand and the analysis of capacity proposed in scenarios 1 and 2, it could be inferred that the institution under study could function adequately with fewer specialists, efforts should be focused on looking at the possibility of making stable contracts with the required medical specialists and in turn organize a good scheme of scheduling shifts or schedules that allow good availability for the attention to the population demanding the medical services offered by the institution.

Reference

Chapman, S. N., *Planeacion y control de la Producción.* Mexico D.F.: Parson Educación., 2004.

Chases, R., & Jacobs, F., *Adminstración de Operaciones: Produccion y Cadena de Suministros* (13a ed.). Mexico D.F.: Mc Graw Hill, 2014.

Eiglier, P., & Langeard, E., *SERVUCCIÓN: El Marketing del Servicio.* Madrid: Mc Graw Hill, 1989.

Garzon Saenz, H., & Redchuk , A., Optimization of shift scheduling for medical staff: an application in the Outpatient Servuccion. *Proceedings of the International Conference on Industrial Engineering and Operations Management*, págs. 1284 - 1294, 2021. Monterrey, Mexico D.F.: IEOM Society International.

Garzón Saenz, H., Solana Garzón, J., & Ortiz Piedrahita, G., Modelo Conceptual Para El Desarrollo De Estudio Del Trabajo Bajo Enfoque Lean En Sistemas De Servuccion. *Proceedings of the International Conference on Industrial Engineering and Operations Management*, págs. 875 - 886, 2017. Bogota D.C.: IEOM Society.

Ministerio de la Protección Social, *Política Nacional de Prestación de Servicios de Salud.* Bogota D.C: Ministerio de la Protección Social. Recuperado el 10 de 07 de 2022, 2005. de https://www.minsalud.gov.co/Ministerio/Documents/Politica%20Nacional%20de%20Prestaci%C3%B3n%20de%20Servicios%20de%20Salud.pdf

Ministerio de Salud y Protección Social., *Aseguramiento al Sistema General de Seguridad Social en Salud.* Bogota D.C.: Imprenta NAcional de Colombia. Recuperado el 25 de 08 de 2022, 2014. de https://www.minsalud.gov.co/sites/rid/Lists/BibliotecaDigital/RIDE/VP/DOA/RL/cartillas-de-aseguramiento-al-sistema-general-de-seguridad-social-en-salud.pdf

Ministerio de Salud y Proteccion Social, *Resolucion 3100 de 2019.* Bogota: Minsiterio de Salud y Proteccion Social. Recuperado el 10 de 07 de 2022, 2019. de https://www.minsalud.gov.co/Normatividad_Nuevo/Resoluci%C3%B3n%20No.%203100%20de%202019.pdf

Pereira Calvo, E., *El Sistema de Servucción.* Costa Rica: Ilumno. Recuperado el 15 de 10 de 2021, 2014. de https://repositorio.usam.ac.cr/xmlui/bitstream/handle/11506/902/LEC%20PROD%200002%202014.pdf?sequence=1&isAllowed=y

Rahmer, B., Garzón Saenz, H., & Garzón Solana, J., Análisis comparativo de modelos de planificación agregada. El caso de las empresas manufactureras colombianas. *Revista De Métodos Cuantitativos Para La Economía Y La Empresa, 33*, 285 - 309, 2022. doi:https://doi.org/10.46661/revmetodoscuanteconempresa.3946

Serna Gomez, H., *SERIE: MANUALES PARA LA PEQUEÑA Y LA MEDIANA EMPRESA.* . Medellin (Colombia): FONDO EDITORIAL Cátedra María Cano.2015.

The World Bank Group, *External Assessment of Quality of Care in the Health Sector in Colombia.* Washington DC: World Bank Group. Recuperado el 15 de 08 de 2021, 2019. de https://openknowledge.worldbank.org/bitstream/handle/10986/32281/External-Assessment-of-Quality-of-Care-in-the-Health-Sector-in-Colombia.pdf?sequence=1&isAllowed=y

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