Pesquisa Operacional (2023) 43: e270103 p.1-18
doi: 10.1590/0101-7438.2023.043.00270103

Printed version ISSN 0101-7438 / Online version ISSN 1678-5142
www.scielo.br/pope
ARTICLES

GLOBAL PERFORMANCE EVALUATION BASED ON MULTIVARIABLE STATISTICAL CONTROL OF A PUBLIC UTILITY COMPANY

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Received December 2, 2022 / Accepted March 2, 2023

ABSTRACT. In this research article, the service provision in a public company was evaluated through multivariate statistical control to determine the performance of its dimensions. For this purpose, the methodology used was: 1) characterization of the information associated with the quality dimensions provided, through consolidated databases recognized for their high level of quality, such as: Elsevier, Inderscience, among others; 2) calculation of Six Sigma metrics (DPMO, Z-level and performance), which will allow from a monthly average, to evaluate the quality of the service provided by the company in a timely and periodic manner in the 12 periods of 2019; 3) Evaluation of the performance of the service dimensions in a global and comprehensive manner, through multivariate analysis. Finally, the quality of the company's service is presented. Thus, allowing the control and continuous improvement of the processes, through its prompt replanting.

Keywords: service, multivariate capability indicator, quality, six sigma.

1 INTRODUCTION

The implementation and control of quality in processes have become one of the indispensable practices in the private business environment (Bloj, Moica & Veres, 2020); as these reflect the level of commitment of companies to quality and good customer service (Kubińska, et al., 2022). Likewise, performance measurement and management control in public companies are perceived as the key to increase the quality of life in the public sector (Avelé, 2021). That is why many companies, independent of their nature, have decided to rely on various techniques and procedures dedicated to statistical quality control, to assess the capacity and performance of the dimensions of their processes (Deeb, et al., 2018), in relation to a series of requirements of interest to customers. Such requirements, called specifications, which are frequently given in objective and limiting value for each of the analyzed characteristics (Costa, Lopes, & Brito, 2019).

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Within the techniques, there is the analysis of multivariate capability indicators, which has been used in production and similar environments, since they provide quantitative measurements of the potential and performance of processes characterized by several evaluable and related quality dimensions simultaneously (Fontalvo, Herrera, & De la hoz, 2020). Thus, allowing the control and continuous improvement of processes for their prompt replanning, being clear about the actions that lead to the optimization of jobs, and thus generate competitive advantages for the company, and at the same time, added value for customers to whom the service is provided (San-jose, Retolaza & Bernal, 2021)

The added value is born from the cautious study of the reactions of customers to the services provided and the requirements not yet satisfied, hence it is evident the characteristics to be improved and/or implemented in an action plan by the company (Sakyi, 2020). This is why companies must have clearly and concisely defined the market segment to be addressed with their services (Costa, et al., 2021), as well as knowing the needs of their customers to create strategic plans that meet them and manage to turn it into a competitive advantage over its competition (Mancosu, et al., 2018).

The previously studied perspective led to the generation of the following problem questions for this research: How to characterize the information associated with the quality dimensions of the service provided? How to articulate the six sigma metrics with the multivariable statistical control techniques to evaluate the performance of the service provided by the company in a timely and periodic manner in the 12 periods of 2019? What multivariable statistical control techniques allow to reliably assess the performance of the service provided by the company in a global and comprehensive manner?

Considering the above, the following objectives emerged for the study: 1) to characterize the information associated with the quality dimensions of the service provided; 2) to evaluate the performance of the service provided by the company in a timely and periodic manner in the 12 periods of 2019; 3) to assess the performance of the service provided by the company in a global and comprehensive manner, through a multivariate capacity indicator.

2 THEORETICAL FRAMEWORK

2.1 Multivariate capability indicators

The analysis of the multivariate capacity of processes is an essential methodology in the study of service quality, with respect to the tolerance that customers have for the objective requirements that they themselves impose, based on their tastes and expectations (Fontalvo, Herrera, & De la hoz, 2020). This process capability allows estimating the level of quality and performance that the company presents, historically monitoring its performance to identify whether the characteristics of the good or service comply with its specification limits.

K. S. Chen, et al. (2003), presented by Fontalvo, Herrera & De la hoz (2020), proposes the monitoring of v characteristics, taking for normality and independence, as well as applying the multivariate capability index, CMT, the following formulation:

$$SM_K^T = \frac{1}{3}\emptyset^{-1}\left\{\frac{(\prod_j^v 1 = 1P_j)^{\frac{1}{k}} + 1}{2}\right\} \tag{1}$$

This methodology evidences a geometric average of the conforming units in the v dimensions studied in the quality monitoring, and also allows to evaluate the nonconformities of the customers through the six sigma metrics.

$$P_j = \sum_{i=1}^{k} 1\frac{Pk}{k} J = 1,2\ldots,v. \tag{2}$$

Where, Pj is the average percentage of nonconformities in the dimension; jth and pk are the probability measures of each of the categories or modalities of the dimension evaluated, in other words $P_k = \left(1 - \frac{N_i}{U_i \times O_i}\right) withi = 1,2,\ldots,k.$ This proposal assumes an optimal process in its performance, when the values present values greater than unity. For the use of the proposed metrics, the operating conditions of the service or the evaluated process must have a sigma level higher than 3, which is evidence of a stable process.

2.2 Six sigma in service companies

With globalization and the high competitiveness it has brought with it; the ability to meet customer expectations, as well as the improvement of quality in service processes, has become an issue of great relevance for companies in this sector (Lizotte-Latendresse & Beauregard, 2018). That is why, companies have decided to adopt new business practices, which lead them to achieve efficiency and excellence in their processes (Ali, et al., 2019).

It is there, where the six sigma methodology becomes known as a tool of great importance for service companies, since it allows them to optimize their resources (De la hoz, Fontalvo, & Fontalvo, 2020), as well as to achieve more efficient processes capable of meeting the customer's requirements; the latter being very relevant when it comes to giving the acceptance of the service and its recommendation. This allows improving the profitability of the company by obtaining greater customer satisfaction (Abbes, et al., 2022), which may possibly lead to customer loyalty with its services, thus increasing its income.

Knowing that six sigma is a customer-oriented strategy (Perramon, et al., 2022), which seeks to reduce the variability that exists in the various processes that occur in companies and that can damage the services and lose the reliability of the company. Within its applicability, it could be said that the model is based on the number of standard deviations or six sigma (process variability) that can correspond to the assumed process quality characteristics (Antosz, et al., 2022). The quality characteristics are determined by the maximum permissible error within the production process, thus determining whether it is capable of meeting customer requirements (Vincent, et

al., 2021). The key to implementing a sigma index is not sigma results, but identifying the root cause of the errors and developing an improvement plan aimed at reducing or eliminating them and thus improving the process (Bennion, et al., 2018).

2.3 Public service

Public services can be considered as the response to the needs of society to have a decent life, regardless of their economic and physical condition. Likewise, all those activities carried out by the government with the purpose of satisfying the needs of the citizens. Hence, providing drinking water, electricity, security, subsidized health, among other services, are part of the primary functions of government, seeking to promote the welfare and human dignity of citizens, taking into consideration the human rights established in the Constitution of Colombia.

It should be emphasized that it is not enough to simply provide the service, but also to comply with the quality standards necessary to provide a good service to society (Longo, Zappatore & Bochicchio, 2019), and thus achieve social and economic development, in addition to effectively reducing the level of poverty by increasing the quality of life (Mamani & Vilca, 2022).

According to, Avelé (2021), Gaie (2021), Nguyen, et al. (2019) and Malpartida, et al. (2022), the quality of public service, is seen as an opportunity for companies to obtain competitive and sustainable advantages in a globalized and changing economic environment.

All of the above, generates the need to study and promote quality in the dimensions of public services, and even more so in Colombia that, despite statistically managing the overall satisfaction of citizens with public services, through the National Administrative Department of Statistics (DANE), there are few individual researchers who have decided to conduct studies focused on making a comprehensive assessment of the quality of the Colombian system.

The new demands of society for administration, combined with the development of industries and achievements in economic and social practice, demonstrate the deficiency of current quality (Gaie & Mueck, 2021), which leads to the redefinition of public organizations, especially organizations that provide services.

The current situation regarding the quality of services is quite worrying (Avelé, 2022), which requires a general transformation of organizations (Laitinen, Kinder & Stenvall, 2018), starting from the study and control of errors, enabled by different statistical control methods that involve reliable and feasible systematic procedures for such studies.

3 METHODOLOGY

The method proposed for the study allowed the characterization of the information associated with the dimensions of quality provided in the public service, through the review of primary information of the company and the conceptual review associated with the object of study of this research.

In order to measure the metrics, primary information provided by the public entity was used to calculate the six sigma metrics (DPMO, Z level and performance), presented in section 3.1.1, was carried out, which allowed, based on a monthly average, to evaluate the quality of the service provided by the company in a timely and periodic manner in the 12 periods of 2019, followed by the use of a multivariate capacity indicator (see section 2.1.), with which the performance of the service dimensions was evaluated in a global and comprehensive manner, through multivariate analysis. Finally, the company's service quality is presented below. In the proposed method, 12 periods were established as criteria to be able to perform an evaluation per year, which will allow longitudinally analyzing the punctual performance through the metrics, and globally and integrally through the Multivariable quality capacity indicator. This can be compared year after year for analysis and decision making.

In order to proceed with the evaluation of the dimensions of quality provided, a series of criteria, formulas and a scheme are presented below:

3.1 Definition of quality dimensions

Considering the nature of the service provided, it was established that the objective of this research would be to evaluate the overall performance from the multivariable statistical control of a public service company, through its dependencies, which are: availability of the reconnection service, bill collection, escalation of attention, call reception, service stability and operation of the attention page.

In order to evaluate the performance of the different departments, a review of the historical PQRS of the year 2019 was carried out, generated in monthly periods, which contain the amount of services rendered (U), number of conformities and non-conformities (n), and an opportunity for error (O) was contemplated, in order to be able to make a study with the six sigma metrics and finally an analysis of the results. In the six sigma methodology, the defects per million opportunities (DPMO) are related to the actual number of defects observed, equation 3, and the sigma level Z, through equation 4.

$$DPMO = \frac{n}{t} x 1.000.000 = \frac{n}{UxO} x 1.000.000 \tag{3}$$

$$Z = 0.8406 + \sqrt{(29.37 - 2.221 x \ln(DPMO))} \tag{4}$$

The following is the type of service to be evaluated with its respective quality dimensions and the metrics to be used for the study:

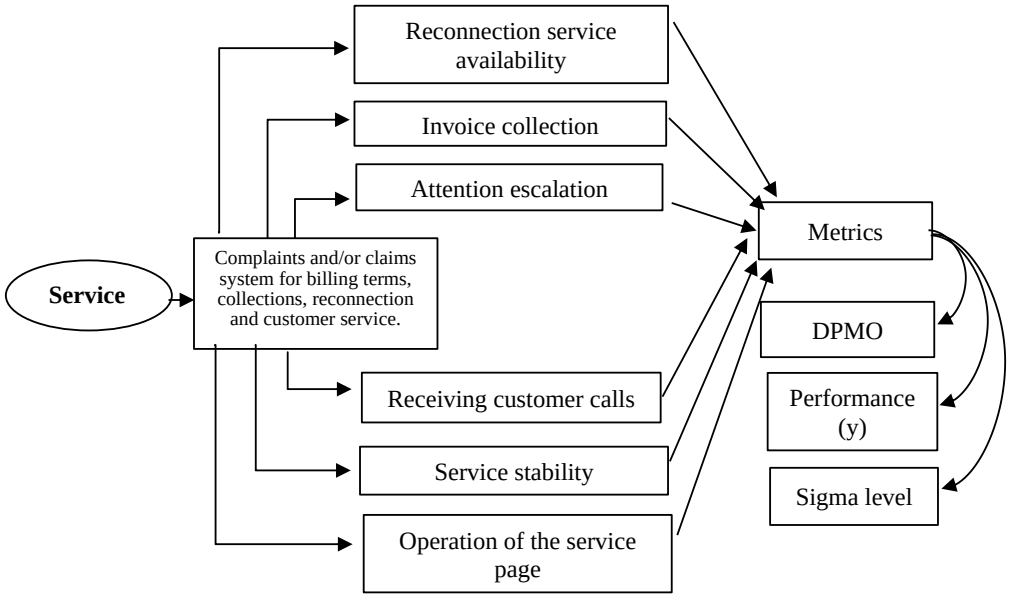

Figure 1 – Operational units to be evaluated in the home Internet server company and their study metrics.

Process performance is calculated by Y in equation 5.

$$Y = \left(1 - \frac{n}{UxO}\right) \tag{5}$$

In the evaluation carried out by means of the six sigma metrics, it is expected that the performance (Y) is equal to or greater than 95% and the sigma level (Z) achieved is equal to or greater than 3, for a good performance. And Excellent if the Z sigma level performance is greater than 4.5. This is to prove that the evaluated processes achieved a good performance in the evaluated dimensions.

4 RESULTS

To evaluate the performance associated with the dimensions of public service quality, the primary information provided by the entity under investigation was tabulated, associated with the performance of the entity's departments, in relation to citizen service, which contained the highest number of complaints and/or claims, in the months from January to December 2019, as can be seen in Table 1.

Table 1 – Consolidated data related to the provision of services to citizens by the ministry's departments.

Period	Dependency	Conforming dimension	Non-conforming dimension (n)
Jan-19	Invoice collection	22961	127
	Reconnection service availability	17309	188
	Attention escalation	39495	344
	Receiving customer calls	18487	134
	Service stability	26269	267
	Operation of the service page	38385	395
Feb-19	Invoice collection	26573	301
	Reconnection service availability	20436	310
	Attention escalation	28270	329
	Receiving customer calls	20505	203
	Service stability	16315	215
	Operation of the service page	25825	196
Mar-19	Invoice collection	30512	179
	Reconnection service availability	14193	105
	Attention escalation	34323	382
	Receiving customer calls	18226	336
	Service stability	19364	296
	Operation of the service page	15085	112
Apr-19	Invoice collection	33675	227
	Reconnection service availability	33177	203
	Attention escalation	18456	278
	Receiving customer calls	13543	128
	Service stability	34030	124
	Operation of the service page	34171	162
May-19	Invoice collection	27813	257
	Reconnection service availability	22427	487
	Attention escalation	38211	187
	Receiving customer calls	36099	105
	Service stability	16284	197
	Operation of the service page	32114	726
Jun-19	Invoice collection	27093	247
	Reconnection service availability	21498	237
	Attention escalation	32778	164
	Receiving customer calls	31580	843
	Service stability	34570	912
	Operation of the service page	31570	380

Table 1 – continued

Period	Dependency	Conforming dimension	Non-conforming dimension (n)
Jul-19	Invoice collection	28645	226
	Reconnection service availability	16744	266
	Attention escalation	35118	327
	Receiving customer calls	15637	143
	Service stability	23551	389
	Operation of the service page	26925	152
Aug-19	Invoice collection	24048	392
	Reconnection service availability	21760	164
	Attention escalation	37324	259
	Receiving customer calls	31828	371
	Service stability	31023	319
	Operation of the service page	13635	98
Sep-19	Invoice collection	31469	398
	Reconnection service availability	17939	220
	Attention escalation	21029	333
	Receiving customer calls	16511	143
	Service stability	30539	136
	Operation of the service page	23396	192
Oct-19	Invoice collection	31192	268
	Reconnection service availability	29792	191
	Attention escalation	32045	111
	Receiving customer calls	27431	388
	Service stability	32632	324
	Operation of the service page	38722	202
Nov-19	Invoice collection	28178	250
	Reconnection service availability	25211	112
	Attention escalation	16704	76
	Receiving customer calls	28034	171
	Service stability	32997	323
	Operation of the service page	31770	110
Dec-19	Invoice collection	29665	383
	Reconnection service availability	24450	245
	Attention escalation	17138	109
	Receiving customer calls	30980	232
	Service stability	30723	135
	Operation of the service page	26466	223

As previously observed, the number of non-conformities is quite low for the level of service provided, which indicates that the process is efficient.

The quantitative estimation of the quality of the service provided to the customer by the departments is achieved through the appropriation of the six sigma metrics. As can be seen in Table 2.

Table 2 – Six Sigma metrics for the citizen service provided by the areas of the Ministry of Housing.

Period	Dependency	Z	DPMO	Y	**Y AVERAGE**
Jan-19	Invoice collection	4,0408	5500,6930	0,9945	0,9913
	Reconnection service availability	3,7994	10744,6991	0,9893	
	Attention escalation	3,8803	8634,7549	0,9914	
	Receiving customer calls	3,9462	7196,1764	0,9928	
	Service stability	3,8239	10061,8028	0,9899	
	Operation of the service page	3,8194	10185,6627	0,9898	
Feb-19	Invoice collection	3,7837	11200,4168	0,9888	0,9887
	Reconnection service availability	3,6729	14942,6395	0,9851	
	Attention escalation	3,7736	11503,8987	0,9885	
	Receiving customer calls	3,8336	9802,9747	0,9902	
	Service stability	3,7268	13006,6546	0,9870	
	Operation of the service page	3,9298	7532,3777	0,9925	
Mar-19	Invoice collection	4,0204	5832,3287	0,9942	0,9892
	Reconnection service availability	3,9389	7343,6844	0,9927	
	Attention escalation	3,7903	11007,0595	0,9890	
	Receiving customer calls	3,5967	18101,4977	0,9819	
	Service stability	3,6699	15055,9512	0,9849	
	Operation of the service page	3,9376	7369,8756	0,9926	
Apr-19	Invoice collection	3,9718	6695,7702	0,9933	0,9924
	Reconnection service availability	4,0058	6081,4859	0,9939	
	Attention escalation	3,6756	14839,3296	0,9852	
	Receiving customer calls	3,8506	9362,8849	0,9906	
	Service stability	4,1819	3630,6143	0,9964	
	Operation of the service page	4,0936	4718,4924	0,9953	
May-19	Invoice collection	3,8588	9155,6822	0,9908	0,9880
	Reconnection service availability	3,5312	21253,3822	0,9787	
	Attention escalation	4,0828	4870,0453	0,9951	
	Receiving customer calls	4,2557	2900,2320	0,9971	
	Service stability	3,7591	11953,1582	0,9880	
	Operation of the service page	3,5149	22107,1864	0,9779	

Table 2 – continued

Period	Dependency	Z	DPMO	Y	**Y AVERAGE**
Jun-19	Invoice collection	3,8637	9034,3819	0,9910	0,9852
	Reconnection service availability	3,7938	10904,0718	0,9891	
	Attention escalation	4,0752	4978,4470	0,9950	
	Receiving customer calls	3,4467	26000,0617	0,9740	
	Service stability	3,4516	25703,1734	0,9743	
	Operation of the service page	3,7610	11893,5837	0,9881	
Jul-19	Invoice collection	3,9159	7827,9242	0,9922	0,9894
	Reconnection service availability	3,6550	15637,8601	0,9844	
	Attention escalation	3,8560	9225,5607	0,9908	
	Receiving customer calls	3,8626	9062,1039	0,9909	
	Service stability	3,6398	16248,9557	0,9838	
	Operation of the service page	4,0338	5613,6204	0,9944	
Aug-19	Invoice collection	3,6450	16039,2799	0,9840	0,9901
	Reconnection service availability	3,9323	7480,3868	0,9925	
	Attention escalation	3,9616	6891,4137	0,9931	
	Receiving customer calls	3,7730	11522,0970	0,9885	
	Service stability	3,8196	10178,0359	0,9898	
	Operation of the service page	3,9492	7136,0955	0,9929	
Sep-19	Invoice collection	3,7423	12489,4091	0,9875	0,9898
	Reconnection service availability	3,7540	12115,2046	0,9879	
	Attention escalation	3,6562	15588,4280	0,9844	
	Receiving customer calls	3,8824	8586,5258	0,9914	
	Service stability	4,1148	4433,5778	0,9956	
	Operation of the service page	3,9018	8139,7321	0,9919	
Oct-19	Invoice collection	3,8853	8518,7540	0,9915	0,9921
	Reconnection service availability	3,9895	6370,2765	0,9936	
	Attention escalation	4,1986	3451,9219	0,9965	
	Receiving customer calls	3,6998	13947,3022	0,9861	
	Service stability	3,8325	9831,2902	0,9902	
	Operation of the service page	4,0609	5189,6002	0,9948	
Nov-19	Invoice collection	3,8736	8794,1466	0,9912	0,9938
	Reconnection service availability	4,1156	4422,8567	0,9956	
	Attention escalation	4,1075	4529,2014	0,9955	
	Receiving customer calls	4,0069	6062,7548	0,9939	
	Service stability	3,8377	9693,8776	0,9903	
	Operation of the service page	4,1987	3450,4391	0,9965	
Dec-19	Invoice collection	3,7345	12746,2726	0,9873	0,9918
	Reconnection service availability	3,8292	9921,0366	0,9901	
	Attention escalation	3,9923	6319,9397	0,9937	
	Receiving customer calls	3,9346	7433,0386	0,9926	
	Service stability	4,1193	4374,8785	0,9956	
	Operation of the service page	3,8923	8355,5023	0,9916	

In order to evaluate the performance of the dimensions of public service quality, the sigma level and the performance of the units were used, and the average of these variables per month of 2019 was calculated, in order to perform an analysis as a whole, as shown in Table 3.

Table 3 – Sigma level assessment and average performance by quality dimension.

Period	Y Average	Z Average
Ene-19	99,13%	3,884989412
Feb-19	98,87%	3,786737112
Mar-19	98,92%	3,825643434
Abr-19	99,24%	3,963216415
May-19	98,80%	3,833755154
Jun-19	98,52%	3,73200857
Jul-19	98,94%	3,827193715
Ago-19	99,01%	3,846787754
Sep-19	98,98%	3,841917354
Oct-19	99,21%	3,944430168
Nov-19	99,38%	4,023358782
Dic-19	99,18%	3,91702456

From Table 2 and Table 3 it can be observed that the sigma Z levels, both point and average all range between $3 > Z < 5$, which shows an acceptable performance, and is consistent with what is expected in a process where six sigma metrics are used, where the ideal performance should range between $3 > Z < 6$.

From the results obtained, it could be said that there is a good monthly performance, which was above 95% in the units as a whole, despite the fact that their sigma level is not very high (3.7; 4).

Continuing with the study of the dimensions of public service quality, we proceed with the presentation of the result obtained from the multivariate indicator, based on the formula below:

$$CM_K^T = \frac{1}{3}\emptyset^{-1}\left\{\frac{\left[\prod_{j=1}^{v}\left(\frac{0{,}9945+..+0.9898}{6}\right)\times\ldots\times\left(\frac{0.9873+..+0.9916}{6}\right)_j\right]^{\frac{1}{6}}+1}{2}\right\}$$

$$CM_K^T = \frac{1}{3}\emptyset^{-1}\left\{\frac{\left[\begin{array}{l}(0,9913*0,9887*0,9892*0,9925*0,9879*0,9853\\ *0,9894*0,9901*0,9898*0,9921*0,9938*0,9918)\end{array}\right]^{\frac{1}{6}}+1}{2}\right\}$$

$$CM_K^T = \frac{1}{3}\emptyset^{-1}\left\{\frac{[(0,980411322)+1]}{2}\right\}$$

$$CM_K^T = \frac{1}{3}\emptyset^{-1}\{0,990205661\}$$

$$CM_K^T = 0,778044847$$

Even without comparing the results achieved by the company with the criteria established in the study, the good performance of the quality provided by the public servant is remarkable.

The criteria to be taken into consideration when evaluating the multivariable indicator of the study will also be presented (Table 4).

Table 4 – Multivariate Analysis Performance Criteria.

Criterion	Service performance
$CM_k^T < 0,5$	Deficient
$0,5 \leq CM_k^T < 0,75$	Good
$CM_k^T \geq 0,75$	Excellent

Taking by consideration the performance criteria, expressed in Table 4, it can be found that the global, periodic and multidimensional performance of the quality dimensions of the public service provided is excellent, due to the fact that the multidimensional geometric quality capacity indicator exceeds $CM_k^T \geq 0,75$ (0,778044847).

5 DISCUSSION

From the results found, it can be noted that as a finding of this research, Table 2 and Table 3 show that the months in which there was the highest performance by the dimensions of quality of public service were November and April consecutively and it is also notorious its relationship with the sigma level, which are the highest in the whole year 2019.

In relation to this research, other authors such as Attia, et al (2021), as well as, Fontalvo, De La Hoz, and Fontalvo, (2022b), assure that the six sigma methodology is a powerful tool in the measurement of services, which guarantee the quality with a high level of statistical confidence and specific performance, in addition to a high level of accuracy and precision, which serves to perform an analysis of capacity and performance, so it is considered valid in several quality control laboratories. Likewise, Costa, A., Et al. (2019), Hariyani, et al., (2022), Cançado, et al., (2019) and Zhu, et al., (2019), consider six sigma as a very complete study methodology and that includes multiple tools and quality techniques for handling real or simulated data analysis projects, which allows researchers to quickly analyze any process.

Similarly, the authors Fontalvo, Herrera and Zambrano (2022c), as well as Kam, A., Et al. (2021), state that the six sigma methodology recognizes that there is a direct correlation between the number of defects and customer satisfaction, so its focus is on finding the most efficient combination

between both aspects, which implies that the process must be between $3>Z< 6$, as can be effectively observed in the analyzed performances of Z in Table 2 and Table 3. For their part, Madhani (2022), Lamine (2022), as well as Fontalvo, Herrera and Zambrano (2022a), add that the sigma value indicates how often defects or malfunctions occur in the process. The higher the sigma level, the fewer defects or errors occur in the process. Thus, increasing sigma reduces the need for testing and inspection, increases process reliability, reduces quality costs and significantly reduces rework.

Meanwhile, authors Swain, et al (2018), Gupta, et al (2021), Steere, et al (2018), Johnson, et al (2019) and Randell, et al (2018), argue that six sigma is a tool that provides competitive opportunities, in today's dynamic, competitive and uncertain business environment, where continuous improvement of process and service quality can create sustainable competitive advantages.

From a multivariate approach to statistical quality control, other authors such as Casacci and Pareto (2022), Fontalvo, et al (2021a), and Khadse, et al (2021), in their studies have used multivariate capability indicators as an integral part in the evaluation of the quality dimensions of goods and services. Thus, showing the relationship between the actual performance of the process and the tolerance limits of customer specifications. In this sense, the author Morelos (2021) shows that the advantage of this multivariate method over the classical methods is that in many cases it reduces the complexity of the problem. Therefore, these latter investigations allow to evaluate the punctual, longitudinal and multidimensional performance of the object of study. This provides an additional measure of application similar to the one used in this research.

6 CONCLUSION

As a scientific contribution, this research work articulates the conception of the theoretical elements associated with the provision of service, as well as the conceptualization of the dimensions of quality and of the different departments of the public sector company, integrated with the six sigma metrics and the capacity indicators of multivariable statistical control.

Similarly, this research presents a structured and reliable methodology in the study of the quality of a public service company, through the analysis of the multivariate capacity indicators, supported by the six sigma metrics that allow evaluating the quality dimensions of the services in a more efficient way; these contributions will be useful to the business and academic environment in their future research. This is a topic that has not been worked on very much, even though it is of great relevance for the competitiveness and efficiency of the processes of the companies.

As a differentiating point, this research provides a novel and little worked method by the scientific community, which is indispensable in the creation of new ideas and the acquisition of new knowledge in the business, scientific and social fields.

On the other hand, the theoretical formulation of the six sigma metrics and the multivariate statistical control capacity indicators provide practical tools for evaluation, analysis and decision-making in-service companies, thus making it possible to meet the requirements of customers,

while ensuring a better quality of life. The above is replicable at local, regional, national or international level in any public or private company.

As future research, the scientific community is invited to replicate the proposed method, considering other departments and other dimensions of quality, associated to a service provision, to measure performance in a periodic, punctual, global, longitudinal and integral way in the processes of public and private companies.

Finally, the use of the six sigma metrics, as well as the analysis of the multivariate capacity indicators, were a key point for the achievement of the objectives set out in the research, since they effectively allowed the evaluation of the stipulated quality dimensions.

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How to cite

MATURANA AGB & HERRERA TJF. 2023. Global performance evaluation based on multivariable statistical control of a public utility company. *Pesquisa Operacional*, **43**: e270103. doi: 10.1590/0101-7438.2023.043.00270103.