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STUDY OF QUEUES AND QUALITATIVE ANALYSIS OF THE PERFORMANCE OF A UNIVERSITY RESTAURANT

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ABSTRACT

The verification of the performance of in-service operations may assist in indicating opportunities for improvement of these operations. In this context, the objective of this article is to verify the level of service of a production operation (university restaurant) on a scale of 0% to 100% according to five performance objectives: service quality, product quality, product flexibility, product cost, and queue system performance. In order to achieve the proposed goal, a four-stage procedure was structured. These steps involve (1) the definition of the application site and its characteristics, (2) the collection of quantitative data in the field and definition of the operational characteristics of the queue, (3) definition and collection of qualitative field data and tabulation of those data, besides (4) analysis of the qualitative data and operational characteristics of the queue. In general, the quality of service, the quality of the product and the flexibility of the product stood out with low level of dissatisfaction. In the case of queuing system performance, there is opportunity for improvement because the actual average wait time is higher than the time that respondents find appropriate to wait in the queue. Another point of improvement is the cost of the product, with an ideal reduction of this value by 33%, according to respondents.

Keywords: Operations, Queue theory, Service level, Performance level.

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1. INTRODUCTION

According to Dias (2008), from the globalization process initiated in the 1980s and the consequent increase in competitiveness, companies began to seek competitive advantages in relation to their competitors, associated with their strategic objectives (quality, speed, flexibility, reliability and costs).

In addition, companies began to look for parallel ways to better measure the performance of their operations, as they would only be able to make informed decisions if previously translated information on performance indicators was available. According to Schirigatti *et* Faria (2006), the main function of performance indicators is to indicate opportunities for improvement within organizations. Performance measures should be used to indicate weaknesses and analyze them in order to identify potential problems that are causing unwanted results. Performance indicators may then point to non-conformities both in goods manufacturing and in service operations.

Specifically in service operations, Coelho *et al*. (2011) emphasize that analyzing performance implies knowing the mix of tangible and intangible elements of the service and the relative importance of each of these components to the customer. This is the first step in the process for improving these operations, which are currently not only addressed from a financial point of view but also from the point of view of operational performance.

Christopher (2005) recommends conducting customer surveys to verify performance. Measuring and evaluating performance are vital for an organization's strategic objectives to be achieved, as well as providing greater accuracy and confidence to managers in the day-to-day decision-making process (Tomoyose, 2014). However, it is not always clear to an organization what their level of performance is and where to start structuring an improvement plan. Thus, the research problem is presented: which performance goal needs to be prioritized with improvement actions? In this context, the objective of this article is to verify the level of service of a production operation (university restaurant) on a scale of 0% to 100% according to five performance objectives: quality of service, quality and flexibility of the product, cost and performance of the queuing system.

To reach the proposed objectives, it was possible to structure a procedure composed of four stages. These stages involve the definition of the application site and its characteristics, the collection of quantitative data in the field and definition of the operational characteristics of the queue, the definition and collection of qualitative data in the field and tabulation of these data, besides the analysis of the qualitative data and operational characteristics of the queues.

In this sense, this article presents in its section 2 concepts about service operations management and customer service level. In its section 3, it approaches concepts associated to queuing theory, besides presenting a basic model of queues. Section 4 is devoted to presenting the structured procedure for verifying the performance level of a service operation. In section 5, this procedure is applied considering a university restaurant located in the Fluminense Federal University Campus in the district Aterrado in the municipality of Volta Redonda-RJ. Finally, we present the conclusions and final considerations, involving the limitations of the work, as well as a suggestion for a new study.

2. SERVICE OPERATIONS MANAGEMENT AND CUSTOMER SERVICE LEVEL

According to Fernandes *et al*. (2011), management is a set of coordinated activities to direct and control an organization. The authors also point out that management is the ongoing review and renewal of that organization, carefully assembled to address changes. According to Martins *et* Laugeni (2005), operations comprise the set of all the activities of the company related to the production of goods and/or services. The same authors mention that in the operation in service, the meeting between the supplier and the customer is necessary. Aranda (2001) points out that this meeting happens in a place called Front Office. It is in this place that the client will build their perception about the service provided. There is also the Back Office, where the service is collected at the supplier's premises, and there is no contact with the customer.

According to Martins *et* Laugeni (2005), it is possible to mention: (1) intense contact with the customer, (2) intensive customer participation in the service, (3) perishability, (4) non-stocking, 5) labor intensive, (6) short lead times, (7) variable and non-standard output, (8) intangibility, (9) difficulty in measuring productivity, and (10) difficulty in measuring quality. All these characteristics can make it difficult to manage operations in service. Even with such difficulties, the service sector stands out. According to Anunciação (2015), the services sector is responsible for a significant portion of a country's Gross Domestic Product, mainly from developing countries, and this sector is one of the main responsible for generating employment.

Liu et Lee (2016) cite that the perceived quality of the service is defined based on the evaluation of the excellence of this service by the customer. Customer satisfaction can be considered to depend on the gap between their expectations and the experience of actual levels of performance. Regarding the level of service, Martins *et* Alt (2009) cites that it is considered how effective a stock was to meet the requests of users. Similarly to services, the more requests are met,

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respecting the specifications, the higher the level of service. Ballou (2001) points out that the service level decision drastically affects the design of the system and can increase logistical costs disproportionately.

According to Fagundes (2006), the level of customer service is an important indicator for the management of the company, which not only allows evaluating the service provided to the client, but also provides visible information for the continuous improvement of the procedures. Based on the evaluation of the level of service by customer perception, the measurement will have relevant criteria.

Wanderley *et al.* (2011) recommend implementing a performance evaluation system with indicators that represent essential elements of success of the current strategy, allowing an objective measurement. In addition, Fornaciari *et al.* (2011) emphasize the importance of a company monitoring its activities and evaluating whether the costs of developing the high level of service to its clients do not surpass the revenues generated by them, balancing the costs with the results. Still in this strategic reasoning, it should be noted that more and more customers are looking for flexibility, superior quality and better services. Thus, companies that seek to continuously improve themselves, having an external and broad view, are more likely to guarantee their survival and to be successful.

Theory of the queues and basic model of queues

According to Li *et* Zhang (2015), queuing is a phenomenon present in many service systems, including transport and communication networks. Understanding queuing dynamics is crucial for the analysis, design, and operations of these systems. For Jingjing *et* Dong (2012), the basic queuing system comprises three components: process of entering or arriving customers, selection process with queuing rules and service or assistance station. Figure 1 shows the single-row model with its elements.

According to Moreira (2007), a queue is formed not only by a problem of capacity to provide service, but also due to the variability both in the interval between arrivals of clients and in the time of assistance or service of these clients.

Moreira (2007) also points out that queuing theory is a field of mathematical knowledge applied to the queuing phenomenon. The author emphasizes that it is a field in constant evolution with more and more extension of its field of application. According to Zavanella *et al.* (2015), queuing theory makes useful queue models available in order to describe the behavior of systems with random demands. The authors cite that these demands may fit into known statistical distributions, such as the normal or exponential distribution. Regarding production systems, the main advantage of the queuing theory is represented by its effectiveness and efficiency in offering a technique that easily describes and characterizes the systems themselves, providing performance indicators.

The system shown in Figure 1 can be further described by Kendall's notation. Kendall (1953) proposed a model composed of six basic information: (A) time distribution between arrivals, in which the exponential distribution is known as Markovian distribution; (S) distribution of assistance or service times; (M) number of service stations, service or number of servers; (K) system capacity, with the maximum number of clients the system supports, including those on standby and those being served; (N) population size (finite or infinite), indicating the potential number of customers that can reach the system and (Q) service discipline at the service desk, describing how clients leave the queue to be served.

Performance Analysis Procedure

In order to achieve the objective of this article, a procedure consisting of four stages was structured. Figure 2 presents these steps: (1) definition of the application site and its characteristics; (2) collection of quantitative data in the field and definition of operational characteristics of the queue; (3) definition and collection of qualitative data in the field and tabulation and (4) analysis of the qualitative data and operational characteristics of the queue. Thus, at the end of the last stage, it is expected to list the characteristics of service level with poor and good performance, in order to help the operations management of the place under study.

In Step (1), one must define the place of study where service operations are performed. It should be mentioned

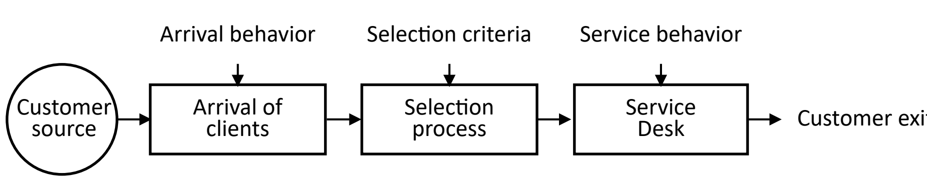

Figure 1. simple queue model.
Source: Moreira (2007).

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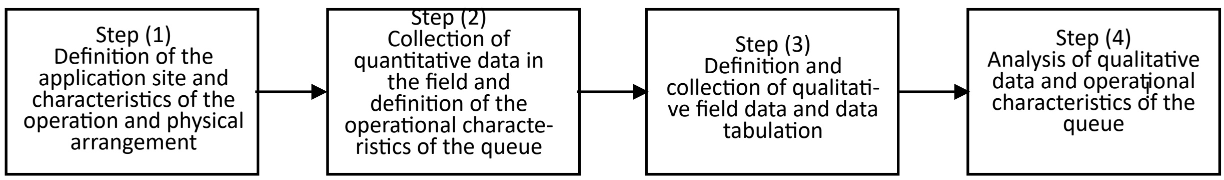

Figure 2. Proposed steps for performance analysis in service operations.

Source: prepared by the authors.

where the operations are performed, as well as details of the physical arrangement. With this, it is necessary to describe the flow of clients and check queue characteristics such as single or multiple queue, single or multiple server, system capacity, population size and attendance discipline.

In Step (2), one must initially collect data in the field. These data are: (1) time between customer arrivals in the queue and (2) service time. These times can be obtained with the use of a stopwatch. After the collection, it is possible to calculate the average of the times between arrivals and the average of the times of attendance. From these average times, the average arrival rate is obtained (λ=1/average time between arrivals) and the average service rate (μ=1/average service time).

In this Step (2), we also verify the time distributions between arrivals and service times. After this check and with information collected in Step (1), it will be possible to characterize the queuing model following Kendall's Notation. This is necessary since each queue model has its own set of equations for the calculation of queue operational characteristics. Table 1 presents the set of equations of the row models MM1 and MG1. The first model presents time distributions between arrivals and time of service Markovian (exponential distributions), with only one server, infinite system capacity and population size, and First Come, First Served (FCFS).

The second model presents Markovian time distribution between arrivals and generic distribution of service times. The other features are the same as the MM1 model. It should also be noted that the verification of the distributions of the collected data can be performed from the hypothesis tests: Chi-square, Kolmogorov-Smirnov, Anderson Darling, among others. There is also the possibility of using statistical software that perform these tests. As an example, the Statfit tool, capable of performing the Kolmogorov-Smirnov and Anderson Darling tests in a practical and fast way.

In Step (3), a method that assists the identification of the opinion of a sample of clients (qualitative data for analysis) should be sought. The most common method is the questionnaire. According to Parasuraman (1991), the questionnaire is only a set of questions presented in writing that aims to provide certain knowledge to the researcher. In this sense, after the elaboration of the questions, which can be performed with the help of the administrator of the place under study, this questionnaire should be applied. After this information collection, the data should be tabulated and presented in graph or table form. It is recommended to elaborate questions related to the five performance objectives cited by Slack *et al.* (2002): Cost, Quality, Flexibility, Reliability and Speed, associated to the product (if it exists) and to the service. In addition, it is recommended that you consult with customers about aspects of the queue, such as the ideal time

Table 1. Equations for the determination of the operational characteristics of a queue.

Description	Symbol	Model MM1	Model MG1
Server occupancy rate	$\rho =$	λ/μ	λ/μ
Coefficient of variation	$Cs =$	$\sigma t/E(t)$	$\sigma t/E(t)$
Average service time	$Ws =$	$1/\mu$	$1/\mu$
Average queue time	$Wf =$	$\lambda/\mu(\mu-\lambda)$	$[\rho(1/\mu)(1+Cs^2)]/[2(1-\rho)]$
Average System Time	$W =$	$1/(\mu-\lambda)$	$1/\mu+[\rho(1/\mu)(1+Cs^2)]/[2(1-\rho)]$
Average number of clients served	$Ls =$	ρ	ρ
Average number of customer in the queue	$Lf =$	$\lambda^2/\mu(\mu-\lambda)$	$[\rho^2(1+Cs^2)]/[2(1-\rho)]$
Average number of customers in the system	$L =$	$\lambda/(\mu-\lambda)$	$\rho+[\rho^2(1+Cs^2)]/[2(1-\rho)]$

Legend: λ – average rate of arrival of customers; μ - average service rate; σt – standard deviation of service times; E(t) – average service times.

Source: Fogliatti et Mattos (2006), Krajewski *et al.* (2009), Pereira (2009).

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to wait in the queue. This is important as it allows a comparison with the average time in the queue calculated in Step (2).

Finally, in Step (4), it is possible to perform the analysis considering the calculated quantitative data (operational characteristics of the queue) and the qualitative data (obtained through the questionnaire) together. In addition to this joint analysis of the queuing system, it is recommended to check other aspects that influence customers' perception of service level: product quality, service quality, product flexibility and product cost. The analysis of these aspects can be performed from the level of satisfaction of the respondents of the questionnaire. At the end of the analysis, one should define the aspects with performance to be maintained and aspects with performance to be improved.

Applying the procedure in four steps

The four-step procedure presented from Figure 2 was applied in a university restaurant. In this case, a package is offered to customers that involves a service and a product. Although the restaurant provides varied snacks, only the lunch offer will be considered. The restaurant's clients are students, teachers and staff attending the University Campus. A sample of these clients was respondents to the survey applied in Step (3) of this study.

Step (1) - Definition of the application site, characteristics and physical arrangement

The university restaurant chosen for the study application is the restaurant located in the Fluminense Federal University Campus in the Aterrado district, in the municipality of Volta Redonda, in the State of Rio de Janeiro. The operations of the restaurant on this Campus began in the year 2015. The implementation of the restaurant project was necessary due to the low supply of restaurants in the vicinity of the Campus and the high demand, since the Campus receives around 2,500 students from undergraduate, *latu sensu* postgraduate and master's degree courses. Although the target audience is the clients associated with the University, the restaurant can be accessed by other clients in the surrounding area, which leads to the consideration that the size of the population is infinite.

Figure 3 shows the physical arrangement of the restaurant located on the ground floor of the Block A building. Guests access the restaurant and head straight for a single row. There is only one server for service. Customers buy lunch and then serve themselves (self-service). Then they sit at one of the tables while they have their meal. After this, they leave through the same place they entered. In this sense, it was verified that the service discipline is FCFS (First Come, First Served) or: the first customer to arrive will be the first customer to be served. Regarding the capacity of the system, it was considered unlimited because of the large number of tables available. There is also the possibility of using part of the study hall next to the restaurant to allocate more tables.

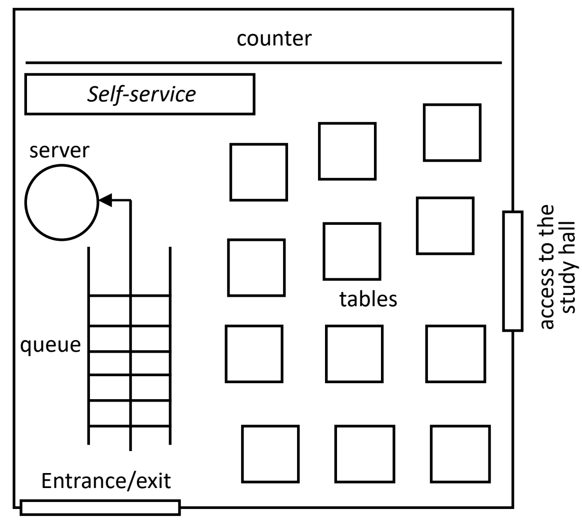

Figure 3. Physical arrangement of the university restaurant.
Source: prepared by the authors.

Step (2): Quantitative data collection and definition of queue characteristics

Table 2 shows the data collected between arrival time and queue service time of the restaurant under study. These times were timed from Monday through Friday in the week of 01/11/2016 to 01/15/2016. Data were collected between 11h and 13h. After collecting and tabulating the data, the next step was to verify the time distributions between arrivals and service times. Statfit statistical software was used. With this tool, it was possible to verify whether the probability distributions of the times collected adhere to Normal, Lognormal, Exponential, Triangular and Uniform probability distributions (all distributions are continuous since the times are continuous variables).

Table 3 presents the results of the adhesion tests for the times between arrivals and service times collected each day. For the times between arrivals, it should be noted that the adhesion test did not reject the null hypothesis of these times if they fit the Lognormal and Exponential distribution for all the days under analysis. On the other hand, the test rejected the hypothesis of fitting the Normal, Triangular and Uniform distributions. For the attendance times, the adherence test rejected the

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null hypothesis of these times if they fit the Exponential distribution in all the days of analysis. Two or more other distributions were not rejected on those days. Thus, because the time distribution between arrivals conforms to the Exponential distribution and because the distribution of service times fits other distributions (not Exponential), the queuing model can be defined as MG1.

From this definition, it is possible to verify the equations that will be used to determine the operational characteristics of the study queue, as presented in Table 1. The average arrival rate (λ) and the average service rate (μ) for each day under analysis. In addition to these rates, Table 4 presents other characteristics of the queue, such as occupancy rate, average system time and average number of customers in the system, among others.

Based on Table 4, it can be seen that the server occupancy rate is above 80% on all days of the analysis. Also note the average time in the queue: minimum of 2.8 minutes on Friday and the maximum equal to 5.6 minutes on Wednesday. Considering the average time in the system, these times rise to 4.0 minutes and 6.9 minutes (the system consists of the queue and service only - after service the customer leaves this system).

Regarding the average number of customers in the system, Friday is the day with the lowest average number (2.7 clients) and Wednesday the day with the highest, equal to 4.7 customers.

Step (3): Definition and collection of qualitative data and data tabulation

At this stage, the questionnaire was used to identify the opinion of a sample of 60 clients. Table 5 presents the applied questions associated with the performance objectives: Cost, Speed, Flexibility and Quality. Most of the questions related to the objective Quality of the product and service. Table 5 presents the data in percentage by following a scale, which gives the respondent the options: (1) very unsatisfactory, (2) unsatisfactory, (3) regular, (4) satisfactory and (5) very satisfactory.

It should be noted that the questionnaire was always applied between 11am and 1pm. Among the questions, some were directed to get feedback from customers about the queuing system. In this sense, questions were asked about the time spent in the queue, its organization and its size.

In addition to all closed questions, respondents were asked openly about the ideal time to wait in line in minutes. Of the 60 customers consulted, two did not respond. The other 58 clients provided responses with a minimum value of 1 minute and a maximum value of 20 minutes. This indicates clients with different levels of patience and, consequently, different perceptions of service level. On average, the ideal waiting time in the queue was 5.26 minutes with a standard deviation of 3.77 minutes. The data set fashion is 5 minutes with quotes from 21 respondents.

Step (4): Analysis of the qualitative data and characteristics of the queue

Table 5 presents a positioning column of what to do for each applied question: fix the problem or maintain performance. This positioning was taken from the analysis of the answers. This analysis is also shown in Table 5. Of the 12 questions applied, in only 5 of them the conclusion is to maintain performance.

Regarding the issues associated with the queuing system, three questions were applied. Questions about queuing time were made and in this case, 85% of the respondents find this time to be regular or inferior. To this closed question, one should associate the open question that asked the ideal time to wait in line, in minutes. The average response time was 5.26 minutes. From Table 4, you can see that the shortest average queue time is 2.8 minutes on Friday and the highest of 5.6 minutes on Wednesday.

Regarding the organization of the queue, although 43% of the answers are geared towards the satisfactory and very satisfactory scales, most have the opinion that this performance is regular or inferior. Another supplementary issue regarding the queue was over its size. Most respondents (77%) thought that this size is regular or had performance below this.

When analyzing the issues associated with quality of service, two issues with a high level of satisfaction are highlighted: the cleanliness of the environment and the attendance of employees. The performance of these should be maintained, as opposed to perceived performance on two issues: ambient noise level and table organization.

The organization of the tables stands out negatively by the percentage of respondents who pointed to this performance as regular (33%). This perception of the respondents can be easily changed by increasing the frequency of table tidying. In the case of the noise level, 42% of the respondents indicated poor or very unsatisfactory performance. It is common to find students studying in groups in the space of the restaurant. As there is a study room next to it, the effort to reduce the noise level a little would be to guide the students to study in this room. Eliminating noise is not possible, but its reduction can be achieved.

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Table 2. Role of time data between customer arrival and service time (times in seconds).

Day			Data																								Average	Standard deviation
Monday	11/01/2016	1	35	36	39	40	40	42	43	43	48	50	50	51	53	53	55	56	59	62	63	63	64	67	68	70	75	86,96	47,21
			78	78	79	80	83	89	93	94	95	95	97	100	103	108	109	111	111	120	150	158	170	189	201	202	230		
		2	53	56	57	59	59	62	63	63	64	66	67	67	69	69	70	70	72	73	73	74	74	75	75	75	75	74,78	9,15
			75	77	77	78	79	79	80	80	80	80	81	81	81	83	83	84	84	85	85	85	86	86	86	87	87		
Tuesday	12/01/2016	1	42	44	44	45	47	49	50	50	50	51	53	54	57	59	59	61	63	64	64	65	66	67	69	69	70	106,68	81,23
			74	75	79	80	85	87	93	99	100	111	119	129	139	145	152	154	155	163	178	192	213	232	283	334	451		
		2	48	50	50	55	55	60	61	61	63	63	69	70	70	71	71	80	80	83	84	85	89	92	92	93	94	89,92	21,94
			94	97	99	100	101	101	102	102	104	105	106	107	109	110	110	111	111	111	115	115	116	119	119	121	122		
Wednesday	13/01/2016	1	37	37	37	37	38	39	40	40	40	41	45	46	47	48	52	55	57	60	61	67	67	69	74	75	76	87,48	63,49
			76	76	77	78	78	79	82	82	85	87	89	92	97	100	101	102	102	105	106	112	162	242	264	295	320		
		2	39	40	40	41	47	48	51	51	53	55	55	59	60	60	61	62	62	64	67	69	69	71	72	72	73	77,70	23,45
			75	76	77	79	81	82	87	88	95	98	102	104	104	104	105	105	106	108	108	108	109	109	109	110	115		
Thursday	14/01/2016	1	52	53	54	57	59	61	61	64	64	65	66	67	68	69	69	69	70	70	77	78	78	80	80	81	81	90,46	30,24
			82	82	84	84	84	91	96	96	97	98	101	103	108	114	116	119	123	129	131	133	134	134	148	153	190		
		2	49	51	52	53	54	57	59	60	61	62	62	63	64	66	67	67	68	69	71	72	73	74	74	75	77	78,50	17,31
			78	78	79	79	82	82	84	84	87	88	89	93	94	97	97	98	99	99	102	105	105	106	106	107	107		
Friday	15/01/2016	1	29	32	32	32	32	33	34	34	35	36	39	44	45	46	47	49	53	53	57	58	65	70	70	72	75	90,34	65,47
			76	77	82	85	87	90	95	99	99	102	103	109	109	116	118	118	119	131	143	155	169	173	258	290	342		
		2	41	45	46	46	50	51	51	52	52	52	55	56	57	57	59	60	62	62	63	64	65	67	67	67	68	73,24	19,60
			73	74	75	75	76	81	81	82	85	85	87	89	89	90	92	92	94	95	95	96	99	101	110	112	119		

Legend: 1 – times between arrivals; 2 - service times. Source: prepared by the authors.

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Table 3. Results of hypothesis tests performed using the Statfit tool.

Distribution	Time data	Monday	Tuesday	Wednesday	Thursday	Friday
Lognormal	Arrival	NR	NR	NR	NR	NR
	Service	NR	RE	RE	NR	NR
Exponential	Arrival	NR	NR	NR	NR	NR
	Service	RE	RE	RE	RE	RE
Normal	Arrival	RE	RE	RE	RE	RE
	Service	NR	RE	RE	NR	NR
Triangular	Arrival	RE	RE	RE	RE	RE
	Service	NR	NR	NR	NR	NR
Uniform	Arrival	RE	RE	RE	RE	RE
	Service	RE	NR	NR	NR	RE

Legend: NR: it does not reject the null hypothesis of the data collected being adjusted to the probability distribution quoted. RE: reject the null hypothesis of the data collected being adjusted to the probability distribution quoted.

Source: prepared by the authors.

Table 4. Operating characteristics of the restaurant queue under study.

Description	Symbol	Monday 11/01/2016	Tuesday 12/01/2016	Wednesday 13/01/2016	Thursday 14/01/2016	Friday 15/01/2016	Unit
Customer arrival rate	λ =	0,690	0,562	0,686	0,663	0,664	customers/minute
Server service rate	μ =	0,805	0,667	0,772	0,764	0,819	customers/minute
Server occupancy rate	ρ =	86%	84%	89%	87%	81%	dimensionless
Coefficient of variation	Cs =	0,123	0,244	0,302	0,220	0,268	dimensionless
Average service time	Ws =	1,2	1,5	1,3	1,3	1,2	minutes
Average queue time	Wf =	3,8	4,3	5,6	4,5	2,8	minutes
Average System Time	W =	5,0	5,8	6,9	5,8	4,0	minutes
Average number of clients served	Ls =	0,9	0,8	0,9	0,9	0,8	customers
Average number of customer in the queue	Lf =	2,6	2,4	3,8	3,0	1,9	customers
Average number of customers in the system	L =	3,5	3,2	4,7	3,9	2,7	customers

Source: prepared by the authors.

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Table 5. Result of the application of a questionnaire on the level of service of the restaurant under study.

Applied questions		Performance Goal	Assessed element	NA	1	2	3	4	5	Total	Positioning	Analysis
1	The price charged for the dish is ...	Cost	Product	0%	30%	28%	25%	10%	7%	100%	Correction	A
2	The time spent in the queue is ...	Speed	Service	0%	18%	27%	40%	10%	5%	100%	Correction	B
3	Queue size is usually ...	Speed	Service	3%	22%	30%	25%	13%	7%	100%	Correction	C
4	The variety in the meals served is ...	Flexibility	Product	2%	2%	8%	47%	32%	10%	100%	Correction	D
5	The queue organization is ...	Quality	Service	2%	12%	15%	28%	30%	13%	100%	Correction	E
6	The flavor and the seasoning of the food are ...	Quality	Product	0%	0%	2%	40%	45%	13%	100%	Maintenance	F
7	The amount served in each serving is ...	Quality	Product	0%	0%	7%	22%	32%	40%	100%	Maintenance	G
8	The cleaning of dishes and cutlery is ...	Quality	Product	0%	2%	3%	17%	43%	35%	100%	Maintenance	H
9	The cleanliness of the environment is ...	Quality	Service	2%	0%	5%	20%	45%	28%	100%	Maintenance	I
10	The noise level of the environment is ...	Quality	Service	3%	18%	23%	37%	13%	5%	100%	Correction	J
11	The organization of the tables is ...	Quality	Service	0%	7%	23%	33%	30%	7%	100%	Correction	K
12	The service of the staff is ...	Quality	Service	0%	0%	3%	10%	45%	42%	100%	Maintenance	L

Legend: 1 - very unsatisfactory; 2 - unsatisfactory; 3 - regular; 4 - satisfactory; 5 - very satisfactory; NA: No answer. Number of questionnaire respondents: 60.

A – The majority (58%) of the respondents think that the price of the dish (R $ 8.50) is very unsatisfactory/unsatisfactory.

B – Most respondents (85%) feel that the time spent in the queue is very unsatisfactory/unsatisfactory/regular.

C – Most (52%) of the respondents think that the queue size is very unsatisfactory/unsatisfactory.

D – Most respondents (78%) think that the variety of meals is regular/satisfactory.

E – Most (55%) of the respondents think that the queue organization is very unsatisfactory/unsatisfactory/regular.

F – Most (58%) of the respondents think that the taste of the food is satisfactory/very satisfactory.

G – Most (72%) of the respondents think that the quantity served is satisfactory/very satisfactory.

H – Most (78%) of the respondents think that cleaning dishes and cutlery is satisfactory/very satisfactory.

I – Most (73%) of the respondents think that the cleanliness of the environment is satisfactory/very satisfactory.

J – Most (78%) of the respondents think that the level of noise is very unsatisfactory/unsatisfactory/regular.

K – Respondents divided into categories very unsatisfactory/unsatisfactory, regular and satisfactory/very satisfactory.

L – Most (87%) of the respondents think that the attendance of the employees is satisfactory/very satisfactory.

Source: prepared by the authors.

In the case of performance associated with the product (food served), three aspects of quality must be maintained: (1) the taste and seasoning of the food, (2) the amount served and (3) the cleaning of the dishes and cutlery. However, aspects associated with flexibility and cost should be improved.

The flexibility of the product was asked from the question about the variety of meals. This aspect can be improved by the percentage of respondents who indicated the level of satisfaction as regular (47%). To make this improvement, it is possible to vary the menu entirely from Monday to Friday. In addition, present a special menu on commemorative dates or, regularly, once a month.

Another highlight is the price charged for the meal (cost aspect). In this case, the low level of satisfaction stands out: 30% of respondents were very dissatisfied and 28% dissat-

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isfied. In the questionnaire, an open question was the ideal meal price. The fashion of the data set is R$ 5.00 with quotes from 23 respondents. The average is R$ 5.67.

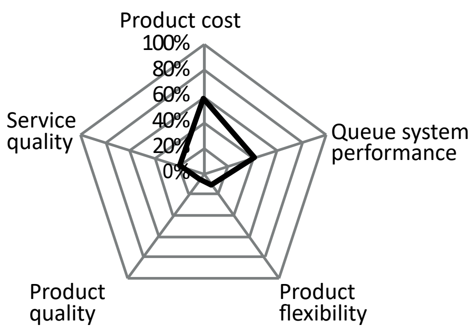

Figure 4. Performance levels (very unsatisfactory + unsatisfactory) in five groups.
Source: prepared by the authors.

This issue of meal cost is the most critical point verified by this study, followed by the question of the performance of the queuing system, as shown in Figure 4.

3. CONCLUSIONS AND FINAL CONSIDERATIONS

The objective of this study was to verify, on a scale of 0% to 100%, the service level of a production operation (university restaurant) according to five performance objectives: quality of service, product quality, product flexibility, product cost and performance of the queuing system. In general, it is possible to verify, through Figure 4, that product quality, product flexibility and quality of service have lower degrees of dissatisfaction, compared to the degrees of dissatisfaction with the product cost and the performance of the product of the queuing system. Therefore, the objective of product cost performance should be prioritized with improvement actions.

With regard to this cost, respondents find the price of the meal expensive. The ideal price would be approximately one-third below the present value. However, in many Federal Universities scattered throughout Brazil the meal costs up to four times less than what is charged at the University under study. These are some reasons for the dissatisfaction and perception of high cost of the meal: (1) most customers are students and many are needy; (2) many are not yet in the labor market and live with the help of their parents; (3) the cost of the meal is a part of the total cost which includes the cost of copies of discipline materials, bus tickets and the cost of other meals (in many cases students spend all day at the University) (4) the other University Campus provides cheaper meals that are supported. From this information, it is worth the effort of the restaurant to reduce the price of meals in order to broaden the perception of service level of the customers, in addition to considering the social issue involved. One way to achieve the value sought by the respondents would be to seek some kind of support to cover part of the total value, as is already done in many Brazilian universities with the “bandejão” (big tray) system. Without the partnership of the restaurant with the University, it is not possible to achieve lower meal prices.

Regarding the performance of queues, the time spent, the size and organization of the queue should be improved. If the average time in the queue and service time (customers are also waiting for this time), in three days of the week, and in the peak period, the average time in the system (in the queue plus in the service) exceeds the time that the customers find it ideal for the waiting. This reduces the perception of customer service level. Thus, this time can be reduced if there is a reallocation of an attendant, without additional costs, in the peak period. Such action has not yet been implemented because the restaurant is unaware of its customers’ dissatisfaction with the time in line. Another way to reduce queuing is to manage demand. One can influence the demand to conduct their meals out of peak period, providing discounts on price. This action would be joint with the previous action of reducing the price of the meal.

Regarding the organization, the place where the queue should be formed is not signaled and it can often be observed that the direct passage to the restaurant counter is obstructed by the queue. In this sense, signaling where the queue should be formed is an option for improving your organization. About queue size, this is an issue associated with the previous approach (time spent in the queue). The actions quoted to reduce this time will also help reduce queue size.

Finally, the limitations of the study are the establishment of conclusions based on a sample of 60 respondents. The ideal would be to increase the number of respondents consulted; and the use of the calculated queuing operational indicators. These are mean, not maximum values, besides being static and non-dynamic values.

It is recommended, for future work, the use of simulation to better understand the behavior of the queue and verification of occupancy rate peaks. By means of the simulation, it is possible to verify the behavior of the queue dynamically, so as to better ground the conclusions on the level of service provided by an operation.

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