Cost Analysis of Queuing System of Postal Office

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Abstract   The paper displays cost analysis of queuing system of particular post office. The selected Post Office is Zilina 1 Post Office in Slovakia. Post office Zilina 1 provides service to almost 4 000 companies and 13 559 households. [1] This paper considers two types of costs. There are costs of services which are associated with increasing or decreasing system capacity. Additional costs are the costs of rejected customers which are costs associated with deciding customers to leave the post office. Aim of this article to indicate the methodology of costs allocation of queuing system of post office and display the costs calculation method of rejected customers. Primary research using the questionnaire and the simulation method proved to be an appropriate tool in this analysis. The results of this paper show the need to take into account the substitutability of the individual services provided at the post office and the repeated arrival of the rejected customer. In the case that a rejected customer requests a service provided also by other postal operators, the post office can deal with loss of customer.

1. Introduction

The queuing system of post office is the system where customers enter the post office in the order be served. Providing services to the customers and the processes associated with it reassure total costs of post office. Calculating the costs of a queuing system includes taking into account the system's direct costs as well as the indirect costs that at first glance can seems as not related to the service provision. These are costs associated with electricity, heat, building rent, and so on. In addition to the direct and indirect costs incurred as a result of the provision of services we also consider the cost of rejected customers. The length of the queue is not limited at the post office. [5,6,7] However, it is possible that the customer is willing to wait for a certain amount of time before he/she leaves the post office. Such a customer may choose to visit another post office or even another postal operator (if the service is provided by another post operator). In this case the postal office losses the customer. Of course, this customer may return to the post office at another time when fewer people are expected to be there. However, if we look at such a situation not only in terms of cost but also in terms of the quality of the provision of postal services, such a situation is unfavorable.

2. Background

When calculating costs, it is advisable to use a general costing formula that can be adjusted according to the actual cost items of the system. The general calculation formula is designed predominantly for manufacturing companies, therefore, when applying to a service company such as Slovak Post, some items of the calculation formula need to be removed or replaced. In this paper the cost breakdown was based on following theory. Cost calculation is a very important process in every business. The goal of businesses is to reduce costs in different areas of their business. The first step in reducing costs is their exact allocation and calculation. [9,10,11,12,13,14] Calculation is the identification or determination of costs, margins, profits, prices or other value in a product, work or service, the activity and operation required to realize them, a business investment action or otherwise a naturally expressed unit. The calculation is a completed calculation completed by determining your own costs or price.

Calculation is a specific procedure that allows you to find out your own costs and other price components on the relevant calculation unit. [9,10,11,12,13,14]

The calculating unit is subject to calculation. It represents a specific performance that is defined by units of measure and is the holder of specific utility features.

The costs can be divided into two types: [9,10,11,12,13,14]
- direct costs,
- indirect costs.

Direct costs are costs that are directly related to the realization of a particular performance and can be determined for one calculation unit. These include, for example, direct material, direct wages, etc. [9,10,11,12,13,14]

Indirect costs are those that are jointly spent on the entire calculated number of multiple types of performance. These include, for example, production overhead, overhead, supply overhead and so on. [9,10,11,12,13,14]

2.1. Generic cost scheme

The generic cost scheme determines the costs of each type of performance. Generic cost breakdown structure (Jankalová, 2014):
1. Direct material
2. Direct wages
3. Other directs costs
4. Operational costs

∑ 1. – 4. Own costs of operation
5. Administrative expenses
6. Supply expenses

∑ 1. – 6. Own costs of performance
7. Cost of sales

∑ 1. – 7. Total own costs incurred
8. Profit
9. Price

The generic cost breakdown structure re-establishes the underlying structure of a company with a production activity, supply, or sales outlet. Under another organizational structure, the cost formula is adjusted according to the cost structure of the business. [9,10,11,12,13,14]

The breakdown of direct and indirect costs is relative because it depends on specific conditions, the type of business, types of production, the choice of the calculating unit, the accuracy of records, and so on. Due to specific conditions, some items may be direct, sometimes indirect, costs. [9,10,11,12,13,14]

2.2. Costs of queuing system of post office

The costs of queuing system of post office are associated with the provision of the service to the customer and the costs of customer rejection. The queuing system is theoretically a system with an infinite front because the number of places in the queue is not defined and the system therefore does not have a rule that rejects the customer. [4,5,6,7,8] From the customer's point of view, however, such a case may occur. After a certain wait time in the queue, the customer can leave the unused service from the system. In this case, the customer has entered the system, but the service is not provided to him. The total costs are:

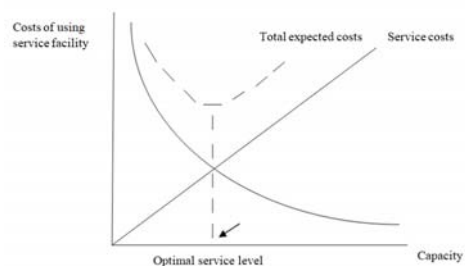$$Total\ costs = Costs\ of\ service\ + Costs\ of\ rejected\ customer \tag{1}$$

Figure 1. Costs scheme of queuing system of post office (Source: Cost analysis for number of servers in a bank using simulation method. Satish Varma, Dr. Sridhar K., SSRG International journal of Mechanical Engineering, volume 2, Issue 5)

Figure 1. shows the types of costs of the queuing system of post office. With the system's capacity increase (in the case of queuing system it is number of service lines), the cost of rejected customers exponentially decreases. With the increase in the number of service lines the average customer waiting time in the queue decreases, and therefore we expect fewer rejected customers. The cost of providing the service grows linearly with the increase in the number of service lines.

3. Objective and methodology

Aim of this article to indicate the methodology of costs allocation of queuing system of post office and display the costs calculation method of rejected customers. In order to achieve our goals, we worked with secondary and primary resources.

We used the following methods in the process of cost calculation of rejected customers:

- **Empirical methods** - serve to collect data describing the real system. To obtain the average time that customers are willing to wait at the post office, the empirical research was used. The questionnaire consists only of question regarding to waiting time.

Table 1. Research plan

Type of research, type and sources of data	Research: quantitative Data: primary Source: customer of Post Office Zilina1
Method of data collection	Questioning
Data collection technique	Questioning: writing, electronical Place of questioning: Post Office Zilina 1
Size of research sample	Target file: 384 respondents
Data analysis method	MS Office (Excel)
Schedule	Duration of the survey: 20.04.2018 – 15.06.2018

$$n = \frac{t_{1-\frac{\alpha}{2}}^2 * \sigma * \sigma}{\Delta^2} \tag{2}$$

- **Exact methods** - specifically statistical methods.

The size of the research sample was calculated according to the following relationships: [3,7,14]

$$\sigma = \sqrt{p * (1 - p)} \tag{3}$$

where $t_{1-\alpha/2}$ is critical value determined by tabulations, σ represents variance calculated from the standard deviation, p is variability of base file (character share) and Δ represents maximum allowable error range. For the required deviation ± 5 and the confidence interval required 95%, the sample size was:

$$n \geq 384$$

- **The simulation method** - to determine the average number of rejected customers per day, we performed several simulations of queuing system of Post office Zilina 1 in LAZARUS software. Since we have already analyzed the queuing system of Post Office Zilina 1, we have already calculated the average input flow and customer service time, i.e.: [2]
   - average customer input flow λ = 1,21 min,
   - average customer service time 1/ μ = 3,43 min.

4. Results

In this paper totals costs of queuing system are consider as costs related service provision and cost of rejected customer. As we mention before generic cost scheme can be adjusted according the costs of particular business. In our case, t. j. Slovak Post is the company providing services so cost scheme was adjusted as is displayed below.

4.1. Service costs

For the purpose of service costs allocation the costs division was processed on direct costs of the queuing system and indirect costs of the queuing system.

Direct costs directly influence the price of services and their size varies with the capacity of the system and the amount of services provided. For example direct wages of postal compartments employees depends on the capacity (number of postal compartments considering 2 employees per 1 postal compartment). At the Post office Zilina 1, at the time of the case study, there are 14 postal compartments employees with an average salary of 750 Euros per month. [1] Direct material represents office supplies used in the provision of services, such as tickets, forms, etc. Other direct costs include health and social insurance from direct wages, work training of those employees, health and safety training of those employees, depreciation, office supplies and toner for printers at each bin.

Indirect costs of the queuing system consist of operating expenses, administrative expenses and sales expenses. While operating expenses include energy consumption, building maintenance, cleaning, payroll fee, internet fee, telephone and etc. Among the administrative costs involve wage of managers of post office, postal health and social insurance of managers of post office and etc. Sales expenses represent promotion and advertising related to postal services.

4.1. Service costs

As we mentioned at the beginning of this paper, the queuing system of post office is not a system that rejects customers. However, and customers often choose to leave

post office before they are served. The costs of rejected customers can be calculated as follows:

Costs of rejected customers = Average revenue per customer
* Number of rejected customers per day

Using a questionnaire 392 responses were obtained. After evaluating customer responses, we found that they are not willing to wait more than 6,5 minutes in the queue. [2]

Based on this finding, we assume that customers waiting for more than 6.5 minutes of mail leave before the service. Several simulations were performed in the order to find out how many customer are rejected. The following table displays results of simulations. [2]

Table 2.   Average number of rejected customers

	Number of customers waiting for more than 6,5 minutes
Simulation 1	8
Simulation 2	6
Simulation 3	7
Simulation 4	9
Simulation 5	6
Simulation 6	6
Simulation 7	5
Average number of rejected customers	6,7

The average revenue per customer of Slovak Post is not publicly available data, so it is not possible to calculate actual costs of rejected customers. However, the aim of this paper was to demonstrate the methodology for calculating such costs. Although it is possible that some rejected customers are going to return to same post office, this situation reduces customer service satisfaction. It must therefore be seen as a negative state which represents a certain cost. The cost of attracting such a group of customers, such as promoting a new service, may be higher in the future than in the case of satisfied customers.

5. Conclusions

The costs of queuing system of post office are costs that are directly and indirectly related to customer service. Although the system does not reject the customer as such, it is possible that the customer decides to leave before becomes involved. In this case, the Slovak Post can lose customers and thus the customer's revenue. In larger risks are services provided by other postal operators such as parcel services. In the case of such services, the customer may actually use the services of another postal operator. With regard to the services provided exclusively by Slovak Post, rejected customers may be dissatisfied. As a result of the customer's dissatisfaction, higher costs may be incurred in the future. Those kinds of costs are associated with measuring the quality of postal services, introducing new services to the market, and re-attempting the satisfaction of those customers.

REFERENCES

[1] Interný materiál Slovenskej pošty, a. s., 2018.

[2] S. Dutkova, Písomná práce k dizertačnej práce "Simulácia poštových procesov", 2018.

[3] H. Bakytova, M. Ugron, O. Kontšeková, Základy štatistiky, ALFA, 1975.

[4] V. Achimska, Modelovanie systémov, EDIS, University of Zilina, Žilina, 2011, ISBN978-80-554-0450-9.

[5] K. Janková, Markovove reťazce a ich aplikácia, EPOS, Bratislava, 2014, ISBN 978-80-562-0075-9.

[6] R. Husek, J. Lauber, Simulačné modely, ALFA, Praha, 1987, ISBN04-326-87.

[7] S. Lyocsa, E. Baumohl, T. Výrost, Kvantitatívne metódy v ekonómii, ElFA, 2013, ISBN 978-80-8086-210-7.

[8] K. Achimský, "Simulácia činnosti poštovej priehradky", in Zborník vydaný na počesť životného jubilea Prof. RNDr. Michala Haranta, Žilina, pp. 127-133, 1990.

[9] Cisko, Stofkova, Ekonomika podniku, EDIS, University of Zilina, Žilina, 2013, ISBN 978-80-554-0756-2.

[10] Poniščiaková, Náklady a kalkulácie, EDIS, University of Zilina, Žilina, 2010, ISBN 978-80-8078-60-0.

[11] M. Jankalová, Finančné účtovníctvo 1, EDIS, University of Zilina, Žilina, 2017, ISBN 978-80-554-1368-6.

[12] M. Jankalová, Kalkulácie v podniku, EDIS, University of Zilina, Žilina, 2014, ISBN 978-80-554-0901-6.

[13] D. Chlebinová, Ekonomika dopravného podniku, EDIS, University of Zilina, Žilina, 2006, ISBN 80-8070-600-X.

[14] M. Tkac, Štatistické riadenie kvality v praxi, Ekonom, Bratislava, 2001.

[15] Satish Varma, Dr. Sridhar K., Cost analysis for number of servers in a bank using simulation method. SSRG International journal of Mechanical Engineering, volume 2, Issue 5