

# Discrete Simulation Modeling of Processes of Customers Service in Retail Drugstores

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## Summary

The article analyses the processes of organizing drugs sale in a drugstore. The types and parameters of timeframes of customers' visits, duration of service by assistants, and probability of appearance of certain types of customers are determined on the basis of calculations in Statistica. The existent possibilities of the organization of retail sale in drugstores are determined. The computer models of the system of mass service of customers in the drugstores by means of a package of simulation modeling ExtendSim are developed. The possibility of taking into account the different number of counters, the number of consultants and doctors, the possibility of appearance of priority clients and breaks are ensured. Calculative experiments are conducted; their results are processed and presented, e.g. the appropriate number of staff according to characteristics of the particular drugstore. Practical implementation assured that the model is adequate and usable.

## Key words

Mass service system, discrete simulation modeling of queues, drugs sales in drugstores.

## Introduction

The conditions of financial crisis have given rise to competition and struggle for the market in all spheres of commerce and production. This also applies to the Ukrainian pharmacy market, the system of retailing products for medical purposes.

However, an essential part of the improvement of sales service by pharmacists in drugstores is the appropriate organization of the sale of medicaments and other products for medical purposes.

## 1. Definition of the Problem and Aims of Research

Selling medicines to customers is a process of mass service, particularly in terms of basic and specific elements which reflect the features of the organization of selling pharmaceutical products.

Computer models of such a system will lead to the minimization of consumer service time and queuing times, optimization of the work of pharmaceutical outlets, etc.

The aim of the research is therefore to optimize the system of mass medical services in the drugstore segment.

Furthermore, the development of a discrete simulation model in the ExtendSim7LT computer modeling tool, the analysis of the results and recommendation of a supposed type of medicine sale, as one of the possible forms of realizing a

project in the organization, represents the possibility of its implementation in one existing, functional part of the enterprise.

## 2. Identification of Statistical Parameters

In order to identify the initial parameters of the model, pilot surveillance was conducted. A number of details were fixed: the time when the customer enters the drugstore, the number of counters, the duration of service by the pharmacists, and the amount of the purchase. The subsequent return of the customers to the counter, cases when the customer left the queue because of its length etc. were also taken into account. The analysis of initial parameters was conducted in the Statistica. The hypotheses of normal, exponential and extreme dispersion were proved for the time lines of the customers' entry, the duration of staying in the queue, and the amount of the purchase (corresponding examples are shown in Figures 1 and 2).

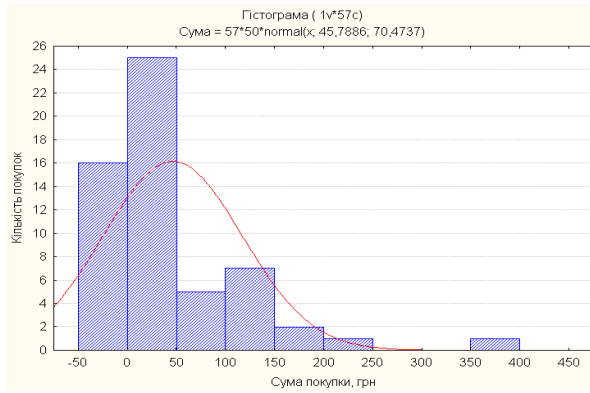


Figure 1 The dispersion for amount of purchase (hryvna)

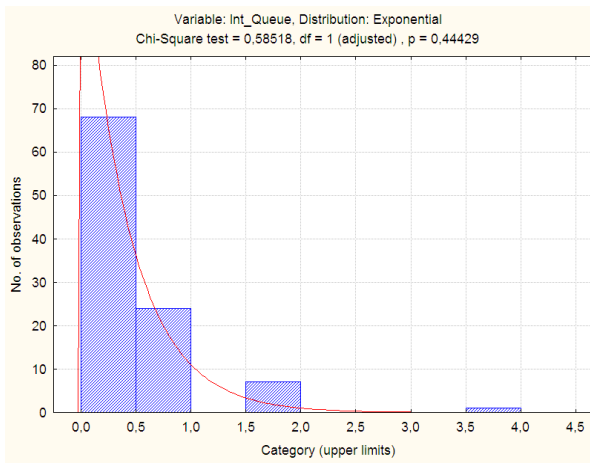


Figure 2 The dispersion for duration of staying in queue (min).

#### 4. The First Step in the Construction of Discrete Simulation Models

The first computer simulation model, shown in Figure 3, has been developed with the use of ExtendSim7LT discrete simulation software.

This model includes the following numbered items (blocks):

- №1 – input model parameters;
- №2 – customers’ entry to the drugstore;
- №3 – joint queue;
- №4 to №6 – service counters (drug sale);
- №7 – drugstore exit and statistical summary collection;
- №8 to №10 – time of service for each counter;
- №11 to №14 - service times representation of the results for multi-time runs;
- №15 and №16 – represent the number of work items that have exceeded their waiting limit;
- №17 – analyses the queue;
- №18 – counts the customers that have left the drugstore at once.

Additional units represent other features of the model:

- №19 to №21 – count repeated service;
- №22 to №24 – the formation of the joint queue and the customers’ return to the common entry queue.

Blocks №25 to №27 reflect the repeated service of different customers at each cash desk.

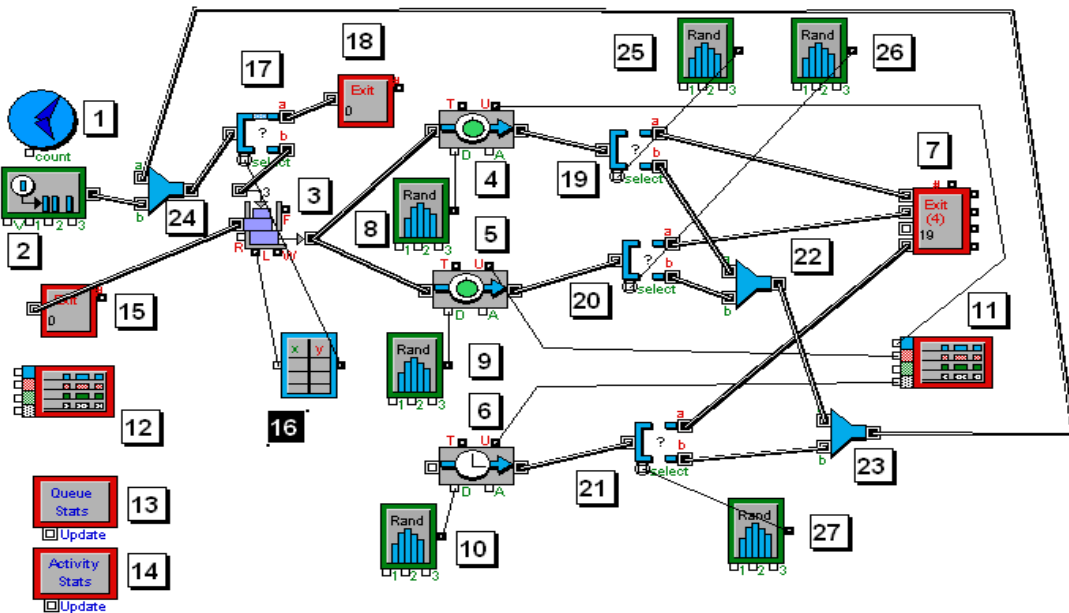


Figure 3 The model with three servicing devices, analyses of the length of the queue and the time of waiting, returning of the customers to the common entrance queue for repeated service.

This first, base model allows the user to change the following entry parameters (measure units are given in brackets):

- time measure units (minutes);
- drugstore working time (hours);
- frequency of customer’s appearance, and its probability depending on different distributions;
- number of service counters (one, two, three);
- duration of service per customer at a single counter (distribution, individual for each counter, with corresponding service time).

In further models, the presence of physicians in the drugstore, priority customers, and separate cash desks in case of epidemics may be taken into account. It is required for imitational modeling, for different groups of drugstores in accordance with models that would reflect the practical organization of selling drugs in them.

### 5. Further Steps in Simulation Model Development

Not departing from the principle of generality, we shall further consider a drugstore with two service counters.

The first model assumes a common queue to all counters. A case of presence of separate queues is presented in Figure 4.

The customer goes to the counter with a shorter queue.

If the queues are identical, the buyer goes to either of the queues.

If the total number of customers in both queues exceeds acceptable level, the new customer leaves the drugstore.

This model contains the following additional blocks:

№28, 30 and №32 – choice of the customer’s path to the shorter queue, where the number of customers is smaller;

№29 and №31 – blocks for the comparison of queue lengths;

№33 and №34 – separate queues before the first and second service counters;

№35 – the sum of total number of customers in both queues;

№36 and №37 – blocks which account for customers’ departure from the drugstore if they find the common queue length unacceptable.

The next step for models is presented in Figure 5.

In this case, after the choice of drugs at the service counter (at the pharmacist), the buyer pays their cost at a separate cash counter, and returns to the common queue to receive the paid pharmaceutical.

For this purpose, a corresponding group of blocks is added to complete a part of the previous model:

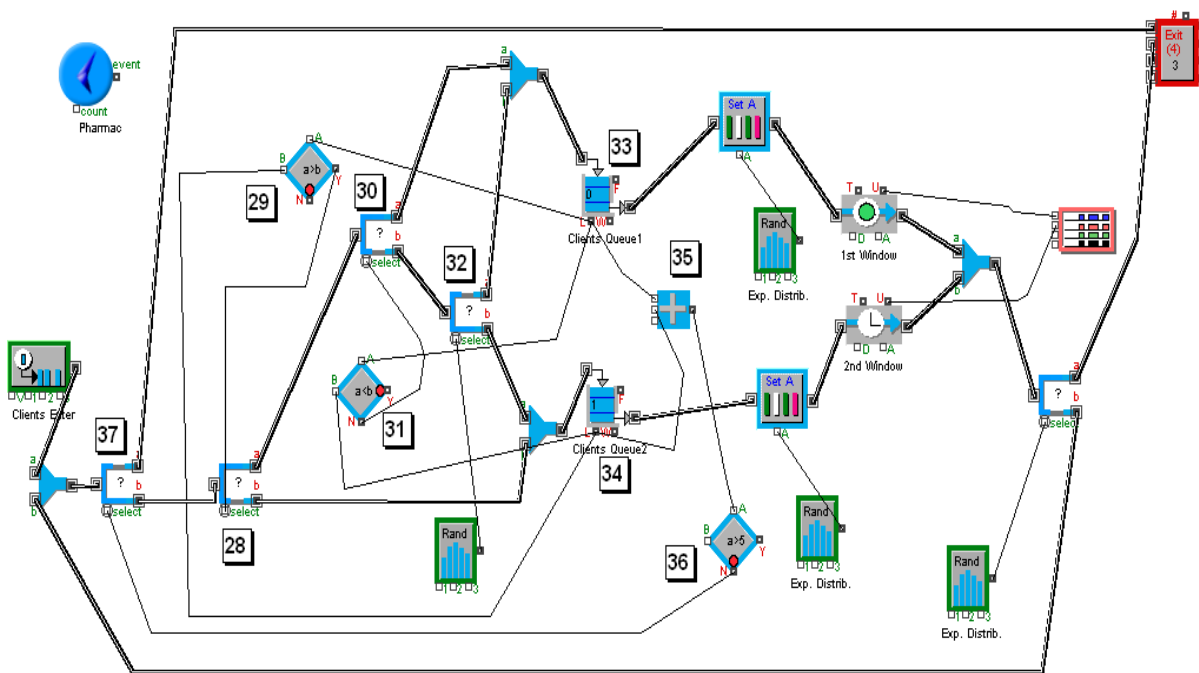
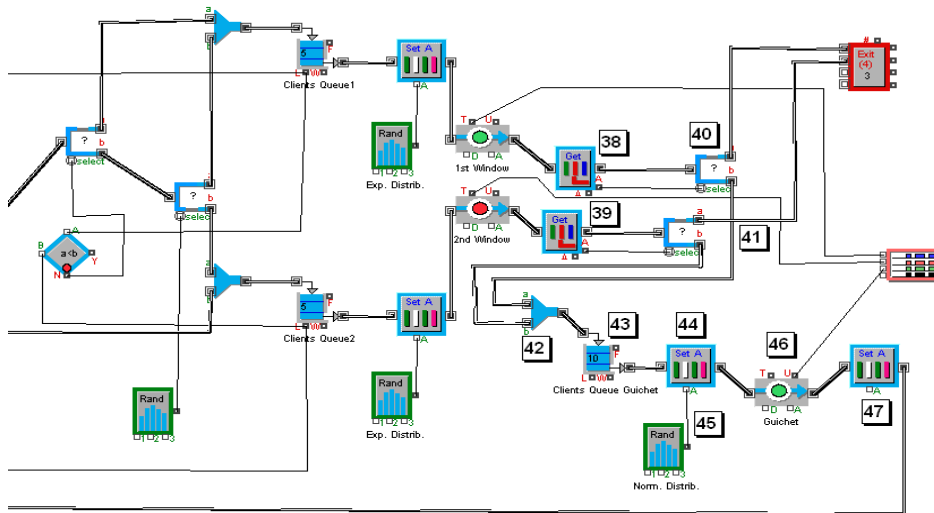


Figure 4 The model with two service counters and separate queues to them, with clients leaving if common queue is unacceptable.



**Figure 5** The model with two service counters and separate cash (pay) counter.

№38 and №39 – fixing (removal) of the attribute, which confirms already rendered customer service at the cash counter (payment for drugs);

№40 and №41 – check of conditions (if payment is required, then the customer goes to the cash counter; otherwise, drugs are already taken by the customer and he/she proceeds to the drugstore exit);

№42 – formation of the common queue from two service counters before the cash counter;

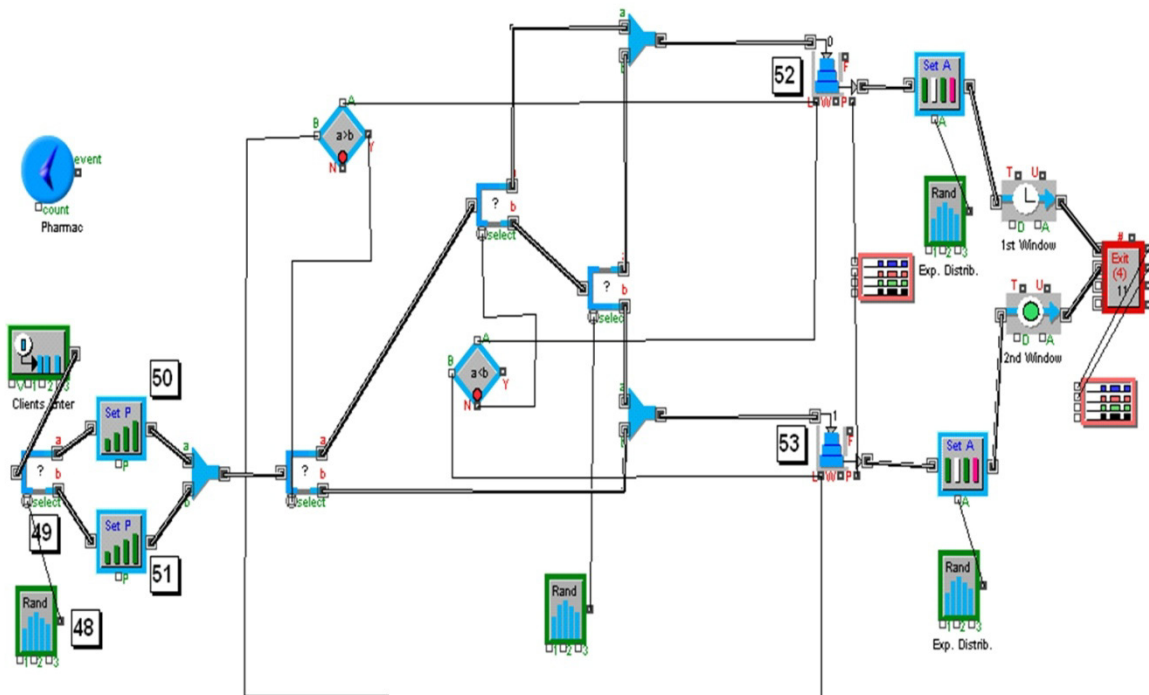
№43 – queue before the cash counter;

№44 and №45 – service time parameters for cash counter;

№46 – cash counter;

№47 – block for set to client attribute, which confirms his/her payment at the cash counter; and the subsequent customers' transition to the beginning of the model (common input and formation of queues for both service counters).

Other blocks are necessary for inclusion in the model to account for the possible occurrence of priority buyers. The corresponding model is shown in Figure 6.



**Figure 6** The model with priority clients

There are the following new fragments:  
 №48 – priority distribution;  
 №49 – block of priorities select;  
 №50 and №51 – sets for different priorities;  
 №52 and №53 – queues before service counters with the analysis of customers’ priorities.

**6. Some Results of Simulations**

Finally, we shall consider the results of numerical simulation for the model showed in Figure 3.

Input parameters for distributions of customers’ appearance and servicing times per customer at each counter are shown in Table 1.

**Table 1** Customers’ appearance and servicing distributions

| Time (min)    | Customer entrance | Servicing time |           |           |
|---------------|-------------------|----------------|-----------|-----------|
|               |                   | Counter№1      | Counter№2 | Counter№3 |
| Minimum       | 1                 | 2              | 3         | 5         |
| Most probable | 2                 | 10             | 6         | 8         |
| Maximum       | 5                 | 12             | 9         | 12        |

Simulation was applied for the cases when only one, two or all three counters are working at a given time.

Modeling results, in particular queue characteristics – queue length and waiting time, and workload per counter for 50 model imitations with a 95% confidence margin are shown in Table 2.

The results of some simulations may be represented in the graphical view, using the special model blocks.

By using modeling result analysis, we can conclude that the sale of drugs at three service counters is the optimum option (also from the point of view of customer service quality and individual pharmacists’ workload).

With this number of counters, a joint queue to all of them is normally absent and does not exceed 4 customers.

Waiting time in the queue is 1.5 minutes on the average, while maximum does not exceed 7 minutes.

Such a service is entirely acceptable for the customers.

Thus, the pharmacists are actively performing their tasks for 90-95% of the working hours, which is quite high – practically, maximum parameter of their efficiency.

Moreover, reduction in the number of counters would produce very long queues and long waiting time for the customers.

Increase in the number of counters would lead to idle time of drugstore staff.

**Table 2** Modeling results with 95% reliability (duration of simulation time is 600 minutes)

| Servicing parameters     | Only counter №1 works | Counters №1 and №2 work | All three counters work |
|--------------------------|-----------------------|-------------------------|-------------------------|
| Average queue length     | 76                    | 24                      | 0                       |
| Maximum queue length     | 151                   | 49                      | 4                       |
| Average waiting time     | 199                   | 64                      | 1,4                     |
| Maximum waiting time     | 400                   | 131                     | 7,5                     |
| Total customers serviced | 71                    | 185                     | 227                     |
| Serviced at counter №1   | 71                    | 81                      | 69                      |
| Workload of counter №1   | 100%                  | 100%                    | 94%                     |
| Serviced at counter №2   | -                     | 104                     | 94                      |
| Workload of counter №2   | -                     | 99%                     | 89%                     |
| Serviced at counter №3   | -                     | -                       | 64                      |
| Workload of counter №3   | -                     | -                       | 88%                     |

We have developed the above described models taking into consideration other factors as well. For example, additional situations were provided for, when the customer leaves the drugstore due to a long queue or waiting time.

The return of customers after the first purchase has also been considered.

Additional situations refer to the provision of consulting services in the drugstore, for example when customers consult the present physician.

We have also researched the options for the optimum number of counters, defining it by the comparison of costs and potential losses due to cases when customers abandon the queue due to its length or waiting time.

**7. Conclusion**

In the above article, a productive approach to simulation modeling for queues in drugstores and customer services has been developed and presented.

Computer models developed in ExtendSim7LT environment enables obtaining the important characteristics of pharmaceutical services, using statistical data and calculation experiments – the presence of queues, waiting time, pharmacists’ workload etc.

As a result, it is possible to improve customer services and optimize the functioning of the drugstores. After the calculative experiments, it appeared that the developed models provide the opportunity to improve the quality of service and, at the same time, to optimize the work of pharmacies on the basis of computer modeling and the analysis of different ways of selling medicines.

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### Oleksandr Dorokhov

Faculty of Economic Informatics,  
Kharkiv National University of Economic  
Kharkiv  
Ukraine

Email: [aleks.dorokhov@meta.ua](mailto:aleks.dorokhov@meta.ua)

### Iryna Zolotaryova

Faculty of Economic Informatics,  
Kharkiv National University of Economic  
Kharkiv  
Ukraine

Email: [zolotaryova@meta.ua](mailto:zolotaryova@meta.ua)

### Ludmila Dorokhova

National Pharmaceutical University  
Department of Management and Marketing in  
Pharmacy  
Kharkiv  
Ukraine

Email: [dorokhova@meta.ua](mailto:dorokhova@meta.ua)