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Simulation Model for Improving the Efficiency of Freight Forwarding Services by a Logistics Company

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ABSTRACT: *The efficiency of freight forwarding companies performance is determined by the qualitative, quantitative, and cost indicators characterizing service provision to economic entities. This paper presents a simulation model of freight forwarding services developed in GPSS World simulation system to determine the average processing time of incoming requests depending on the type of clients; research and comparison of the efficiency of two directions of requests depending on transportation; determine the total customer service time depending on the department; explore and improve the efficiency of logistics company by optimizing the construction of transport and logistics services. The developed simulation model can be used to determine the optimal structure of the organization of the work of a logistics company in the provision of forwarding services.*
KEYWORDS*: freight forwarding services, queuing system, service request, simulation modeling.*

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I. INTRODUCTION

Transport provides full satisfaction of the needs of national economy and population in transportation. More than half of the volume of traffic is carried out road transport, since it is the most mobile and maneuverable. It also allows the delivery of goods from places of production to places of consumption.

In order to increase the volume of cargo transportation by road, it is important to provide high-quality freight forwarding services to potential customers, since at present the object of research of the transport market is the customer and his needs. The more profitable the transportation is, the more interested the customer is.

The main criteria for choosing a freight forwarding company are:

– the cost of transportation (total transportation costs, taking into account transport tariffs);

– speed of transportation (total travel time: from the starting point of departure to the final destination);

– reliability of transportation (delivery of cargo in one piece at the specified time and place).

In addition to the main criteria, the following additional criteria can be identified, which should also be taken into account when choosing freight forwarding companies:

– quality of services provided;

– the possibility of providing special equipment for the transportation of certain categories of goods (dangerous, fragile, requiring a certain temperature regime of goods);

– customer orientation (system of discounts and special offers);

– possibility of delivery of cargo "door to door";

– reputation in the transport services market (good customer history and positive feedback);

– qualification of personnel;

– cargo monitoring (the ability to track the transportation process);

– compliance with the requirements and quality standards of the transportation process;

– mandatory insurance compensation in case of loss / damage of cargo;

– financial stability of the carrier;

– availability of additional services to ensure an increased level of security of the transported cargo (insurance, information support, additional packaging);

– many years of experience in the transport services market.

A freight forwarding company`s performance is analyzed according to indicators characterizing its activity areas where the company`s performance before and after the implementation of specific measures is compared. Each of the company`s goals requires the analysis of a number of indicators that allows making managerial decisions on the economic feasibility of the proposed actions, their benefits, and risks [1].

The most common aspects that are usually subject to constant reforms in freight forwarding companies operation are workforce and material-and-technical capacity management. Potential measures that are considered to optimize the staffing level in order to provide complex and timely freight forwarding service provision, as well as derive economic benefits from the operation are the assessment of costs, revenues, and profits generated from the activity [1].

The aim of the work is to develop a simulation model of freight forwarding services developed in GPSS World simulation system [2, 3, 4] to

– determine the average processing time of incoming requests depending on the type of clients (VIP client, client, one-time application);

– research and comparison of the efficiency of two directions of requests depending on transportation (export, import);

– determine the total customer service time depending on the department;

– explore and improve the efficiency of logistics company by optimizing the construction of the workflow for provision of transport and logistics services.

II. PROVISION OF FORWARDING SERVICES BY A LOGISTICS COMPANY AND TIME ESTIMATION

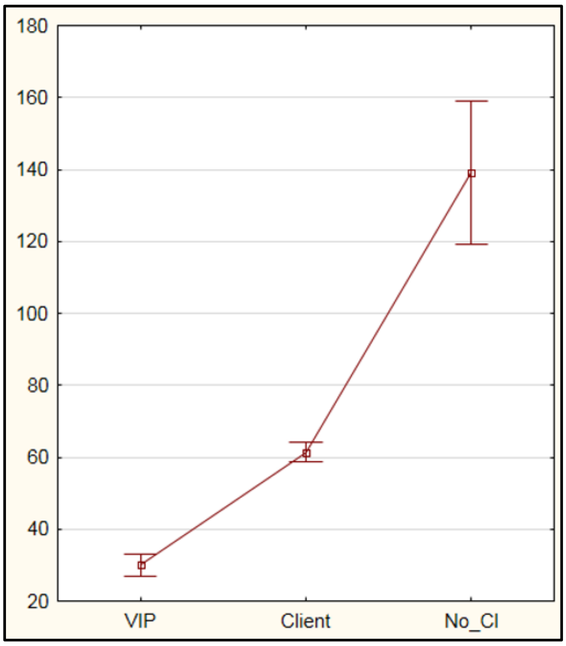
The most important factor is the duration and quality of service provision. To plan this business process, we consider it appropriate to rationally organize freight forwarding services rendered by an international logistics company.

An international logistics company provides services in the field of international logistics to partners in such industries as:food products, alcoholic beverages, automotive industry, medicines, flowers, hi-tech products.

The company's customer base can be divided into three main sectors: VIP client (30 %), regular client (50 %), one-time client (20 %). The division is based on the number of transport services provided to customers.

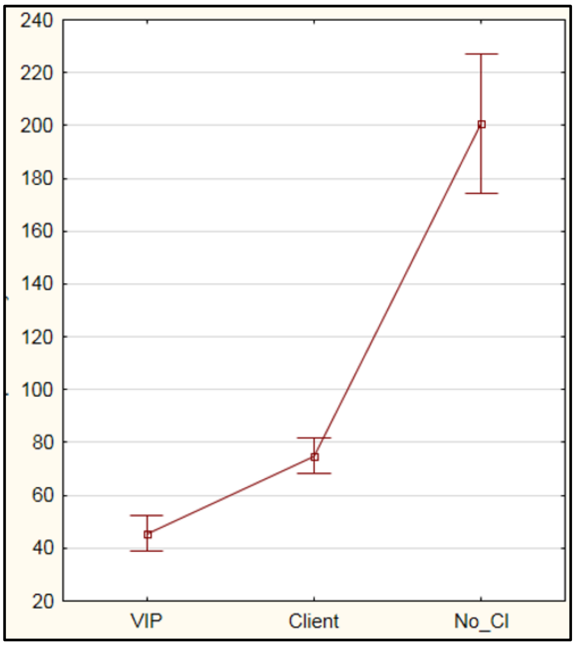
We will evaluate the average service time of applications for: clients of different types (VIP client, regular client, one-time client), types of products, export and import operations by employees of various departments.

To assess the statistical relationship between the type of client (VIP client, regular client, one-time client) and the average time of application service by a client manager in the program "Statistica" [5, 6], the Kruskal-Wallis test was used, which is designed to evaluate the differences in the averages of several samples according to the level of any indicator, and the Fisher test, which is used to evaluate the differences in the variances of several samples.Figures 1-2 show whiskers diagrams of the average service time by a client manager and planning department, depending on the type of client.



KW-H(2;120) = 96,3733; p = 0,0000
F (2; 117) = 178,248; p = 0,0000

Fig. 1.The significance of influence of clienttypeon the average service timeby client manager

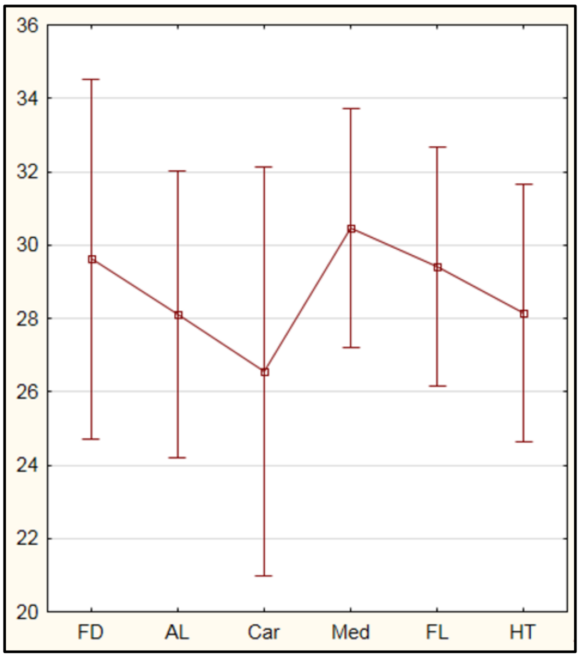


KW-H (2;120) = 67,833; p = 0,0000
F (2; 117) = 154,5781; p = 0,0000

Fig. 2. The significance of influence of client type on the average service time byplanning department

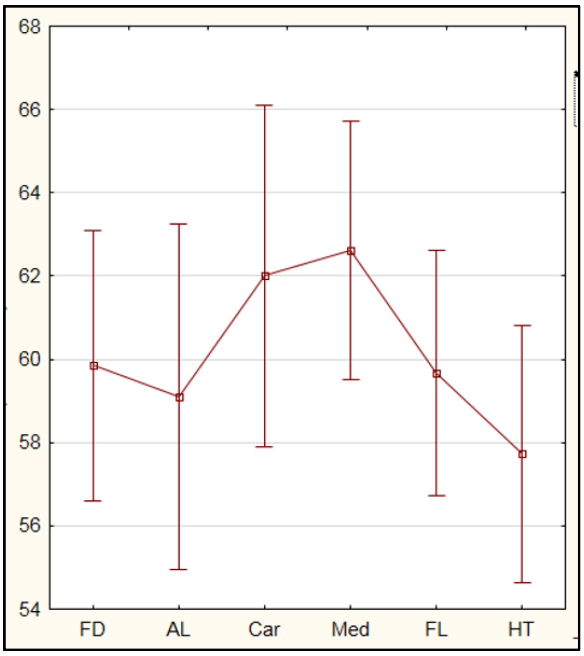
The calculation results showed that according to the Kruskal-Wallistest and Fischertest, p<0.05, which indicates the significance of influence of clienttypes (VIP client, regular client, one-time client) on the average service time by client manager and planning department.

Figures 3-5 show whiskers diagrams of the average service time depending on the type of cargo (FD - food products, AL – alcoholicbeverages, Car – automotiveindustry, Med – medicines, FL – flowers HT – hi-tech products) for VIP client, regular client and one-time client.



KW-H (5;75) = 2,5449; p = 0,7697
F (5; 69) = 0,5104; p = 0,7675

Fig. 3.The significance of influence of cargo type on the average VIP client service time



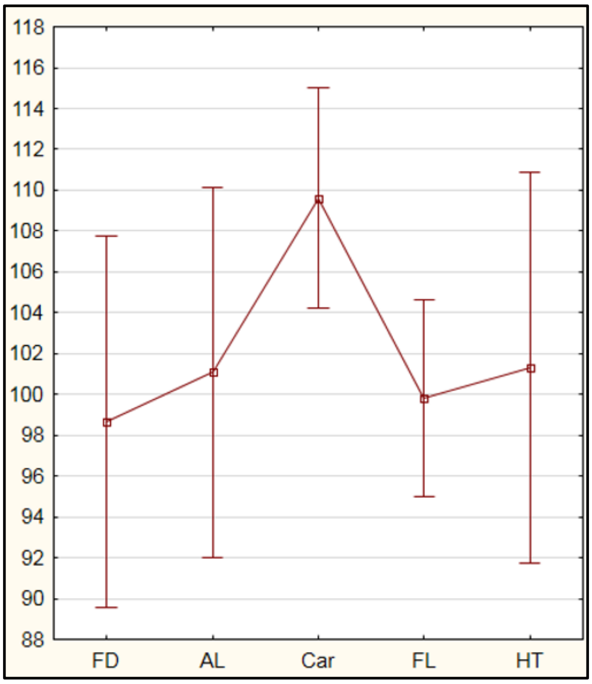
KW-H (5;75) = 6,5016; p = 0,2604
F (5; 69) = 1,4427; p = 0,2201

Fig. 4.The significance of influence of cargo type on the averageregular client service time

The results showed that the type of cargo does not affect the average time of VIP client, regular client and one-time client, because p>0.05.

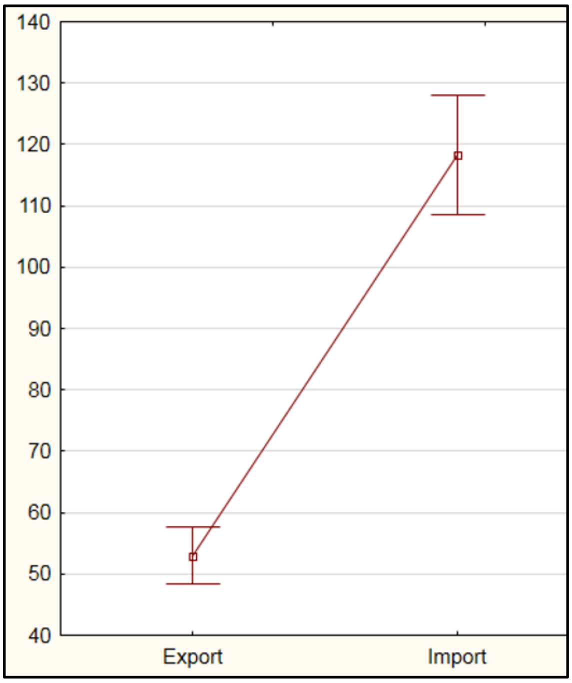
Thus, there is no need to take into account incoming flows by type of cargo in the simulation model. Different types of cargo can be specified in the same flow of requirements for different types of clients.

Figure 6 shows whiskers diagram of the average service time depending on transportation (export, import). The results showed that the direction affects the average service time of the application, because p<0.05.



KW-H (4;75) = 7,7409; p = 0,1015
F (4; 70) = 1,7549; p = 0,1478

Fig. 5.The significance of influence of cargo type on the averageone-time client service time



KW-H (1; 60) = 44,2709; p = 0,0000
F (1; 58) = 151,7513; p = 0,0000

Fig. 6.The significance of influence of transportationdirectionon the average service time

An estimate of the processing time for an incoming application is presented in Table 1.

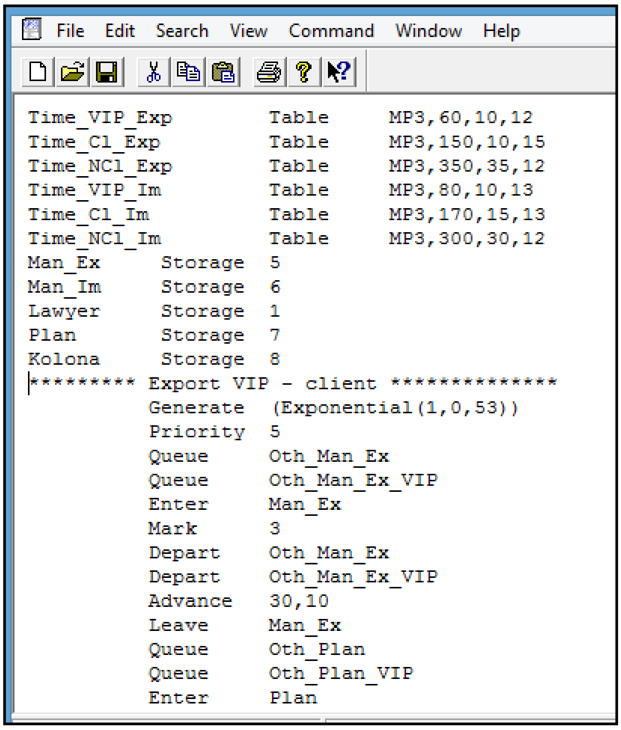
Table (1). Evaluation of the processing time of an incoming application.

	Client type	Assessment of importance	Client Manager	Lawyer	Planning Department	Transport Department
Export	VIP client	6	30 ± 10min	-	45 ± 10 min	30 ± 5 min
	Regular client	4	60 ± 15min	-	45 ± 10 min	80 ± 15 min
	One-time client	0	140 ± 20 min	20 ± 10 min	75 ± 10 min	120 ± 25 min
Import	VIP client	4	40 ± 10 min	-	60 ± 10 min	30 ± 5 min
	Regular client	2	60 ± 20 min	-	70 ± 10 min	75 ± 15 min
	One-time client	0	140 ± 20 min	10 ± 5 min	45 ± 10 min	110 ± 5 min

Estimates of the average time (Table 1) for processing customer requests of various types (VIP client, regular client, one-timeclient) for export and import operations by employees of various departments will be the initial information for the simulation model for service time.

III. SIMULATION MODEL OF FREIGHT FORWARDING SERVICES BY A LOGISTICS COMPANY

To justify the choice of the optimal structure of an international logistics company and optimize the processing of incoming requests, a mathematical model of queuing system is proposed. The proposed queuing model is implemented in GPSS World simulation system [2, 3, 4] (Figure7).



```
File  Edit  Search  View  Command  Window  Help

Time_VIP_Exp         Table      MP3,60,10,12
Time_Cl_Exp          Table      MP3,150,10,15
Time_NCl_Exp         Table      MP3,350,35,12
Time_VIP_Im          Table      MP3,80,10,13
Time_Cl_Im           Table      MP3,170,15,13
Time_NCl_Im          Table      MP3,300,30,12
Man_Ex      Storage  5
Man_Im      Storage  6
Lawyer      Storage  1
Plan        Storage  7
Kolona      Storage  8
********* Export VIP - client **************
          Generate  (Exponential(1,0,53))
          Priority  5
          Queue     Oth_Man_Ex
          Queue     Oth_Man_Ex_VIP
          Enter     Man_Ex
          Mark      3
          Depart    Oth_Man_Ex
          Depart    Oth_Man_Ex_VIP
          Advance   30,10
          Leave     Man_Ex
          Queue     Oth_Plan
          Queue     Oth_Plan_VIP
          Enter     Plan
```

Fig. 7. Program listing

As a result of the simulation, the following statistics on queues and devices were obtained:

QUEUE	MAX	CONT.	ENTRY	ENTRY(0)	AVE.CONT.	AVE.TIME	AVE.(-0)	RETRY
OTH_MAN_EX	18	0	65836	25639	1.538	23.553	38.575	0
OTH_MAN_IM	9	0	38600	35450	0.057	1.476	18.089	0
OTH_LAW	6	0	20839	14066	0.091	4.397	13.528	0
OTH_PLAN	20	2	104429	60178	0.774	7.469	17.626	0
OTH_KOL	37	0	104420	30044	2.985	28.818	40.458	0
OTH_MAN_EX_VIP	7	0	19231	7476	0.158	8.284	13.553	0
OTH_MAN_EX_CL	12	0	36096	14034	0.675	18.843	30.829	0
OTH_MAN_IM_VIP	6	0	12578	11521	0.013	1.014	12.064	0
OTH_PLAN_VIP	6	1	31807	17545	0.111	3.520	7.851	0
OTH_MAN_IM_CL	5	0	15691	14475	0.021	1.345	17.350	0
OTH_PLAN_CL	10	1	51783	29880	0.326	6.336	14.980	0
OTH_KOL_VIP	7	0	31804	9008	0.226	7.161	9.990	0
OTH_MAN_EX_NCL	15	0	10509	4129	0.706	67.670	111.465	0
OTH_KOL_CL	10	0	51778	14807	0.771	15.019	21.034	0
OTH_MAN_IM_NCL	7	0	10331	9454	0.023	2.239	26.374	0
OTH_PLAN_NCL	13	0	20839	12753	0.337	16.311	42.037	0
OTH_KOL_NCL	33	0	20838	6229	1.988	96.159	137.159	0

STORAGE	CAP.	REM.	MIN.	MAX.	ENTRIES	AVL.	AVE.C.	UTIL.	RETRY	DELAY
MAN_EX	5	1	0	5	65836	1	4.180	0.836	0	0
MAN_IM	6	3	0	6	38600	1	2.868	0.478	0	0
LAWYER	1	1	0	1	20839	1	0.311	0.311	0	0
PLAN	7	0	0	7	104427	1	5.547	0.792	0	2
KOLONA	8	1	0	8	104420	1	7.358	0.920	0	0

As a result of the simulation, the average service time of an incoming request is shown in Table 2.

Table (2). Results of modeling the processing of incoming requests from customers

Operations for processing incoming requests	Average maintenance time, min (MEAN)	Mean square deviation, min (STD.DEV.)
VIP client (export)	115,015	13,428
Regular client (export)	202,247	23,299
One-time client (export)	464,731	172,401

VIP client (import)	141,712	15,616
Regular client (import)	235,656	40,373
One-time client (import)	429,148	173,825

Histograms of the average service time of incoming requests from customers for forwarding services are shown in Figures 8 –13.

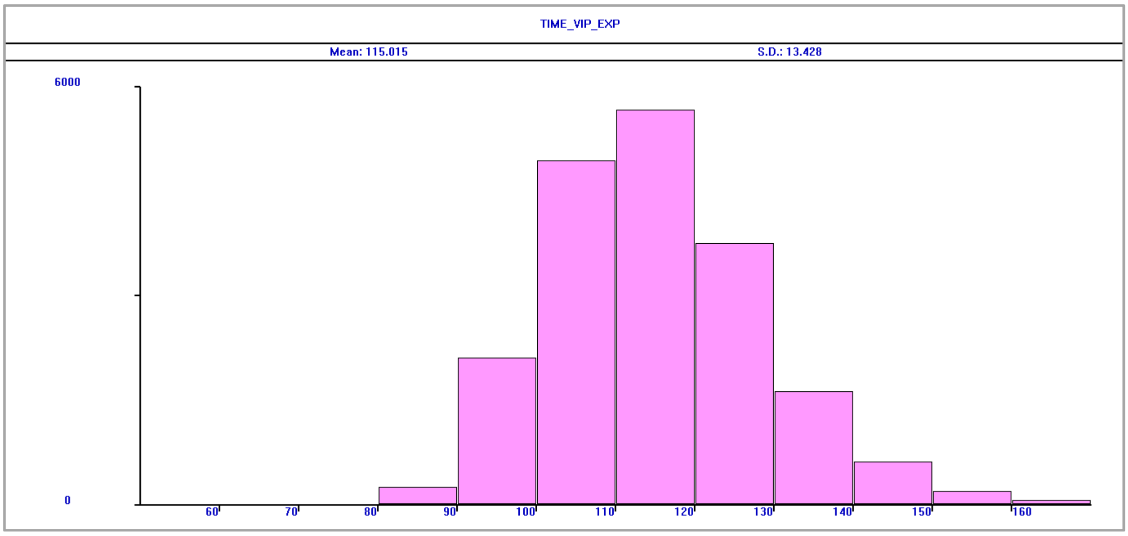


Fig. 8. Distribution of application service time for VIP client (export)

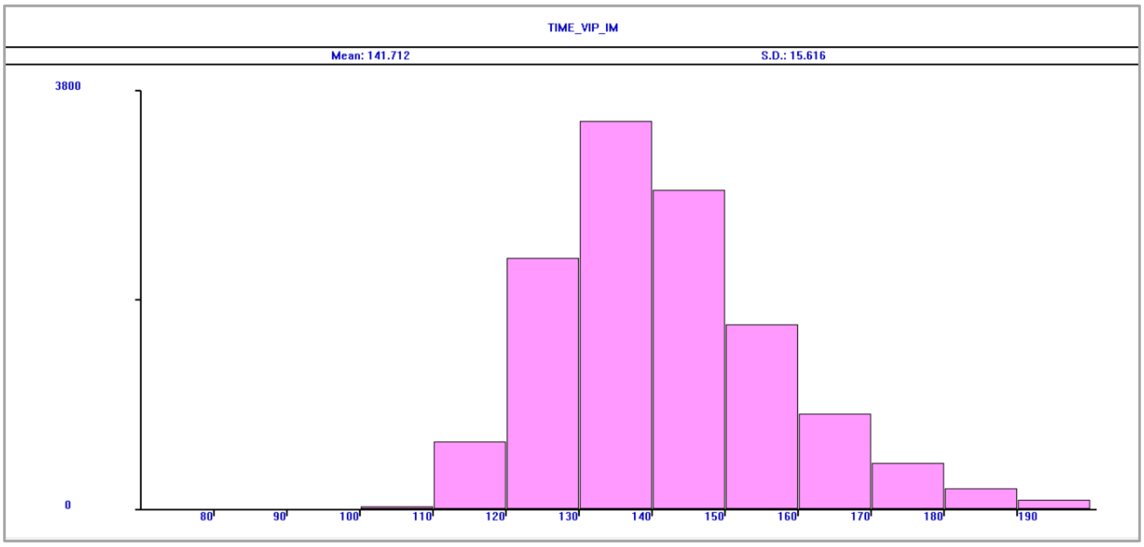


Fig. 9. Distribution of application service time for VIP client (import)

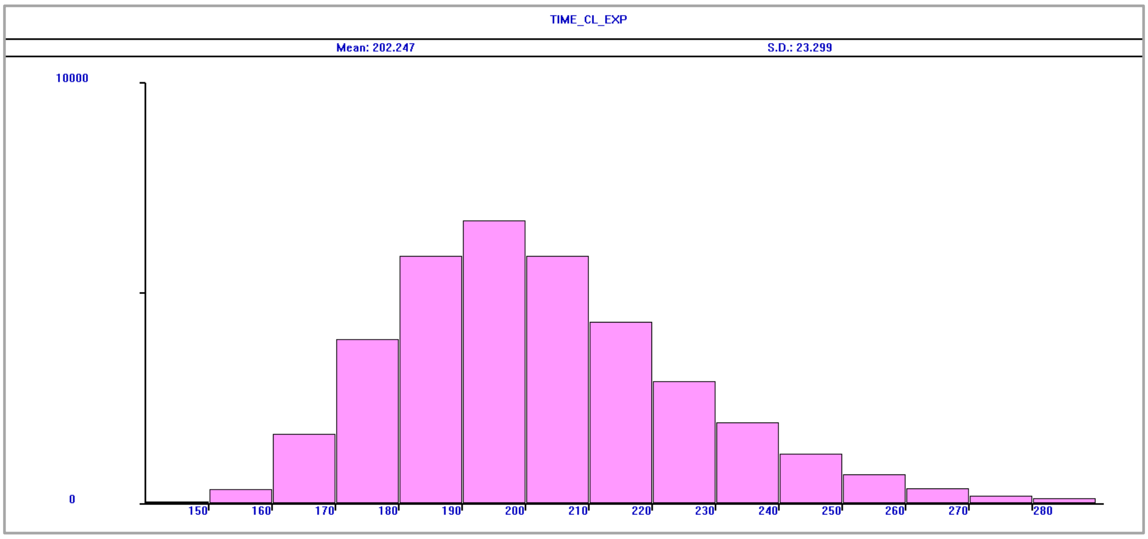


Fig. 10. Distribution of application service time for regular client (export)

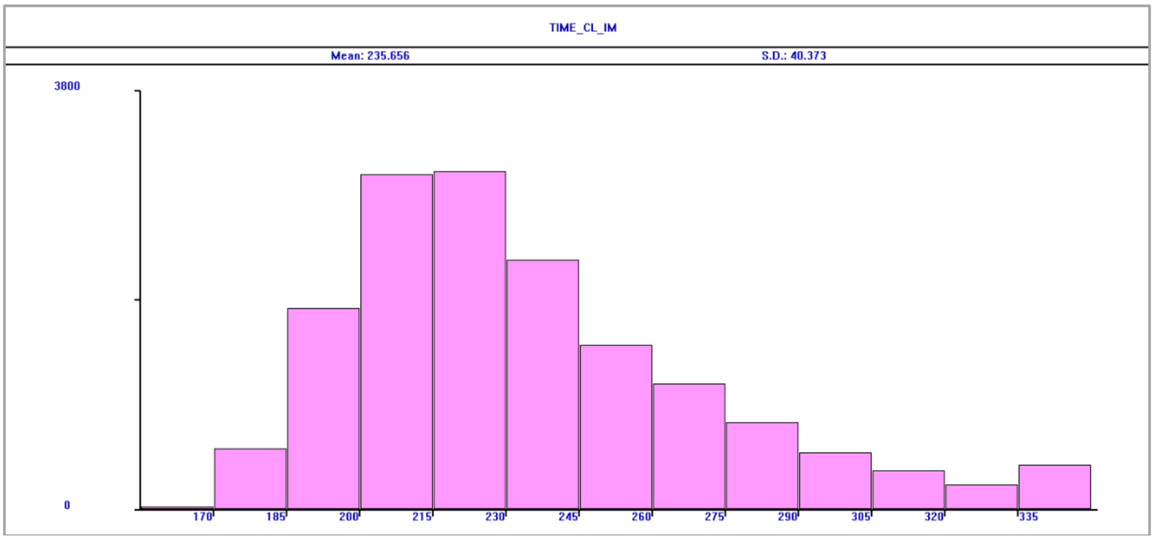


Fig. 11. Distribution of application service time for regular client (import)

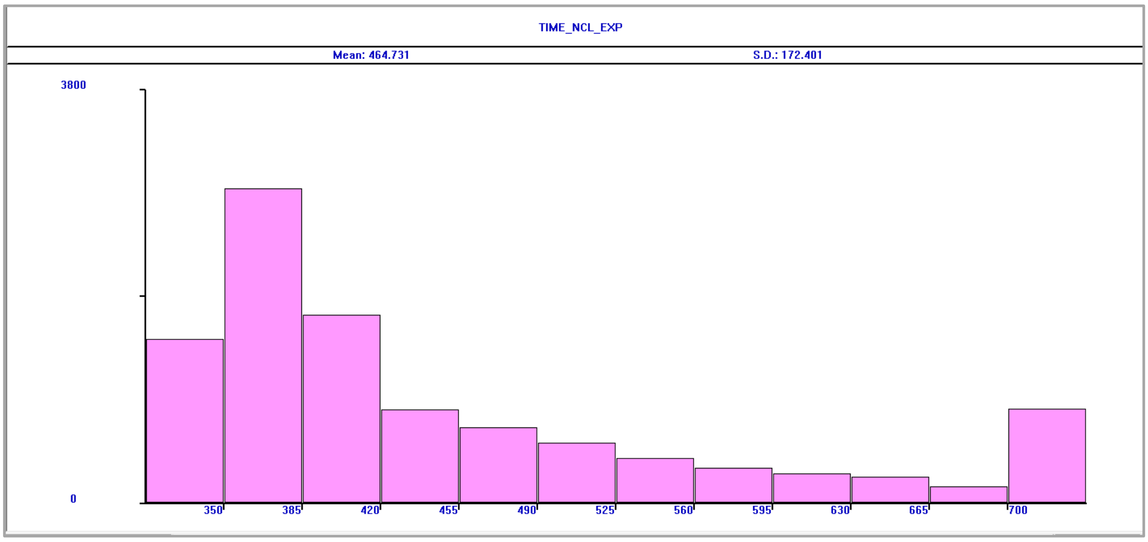


Fig. 12. Distribution of application service time for one-time client (export)

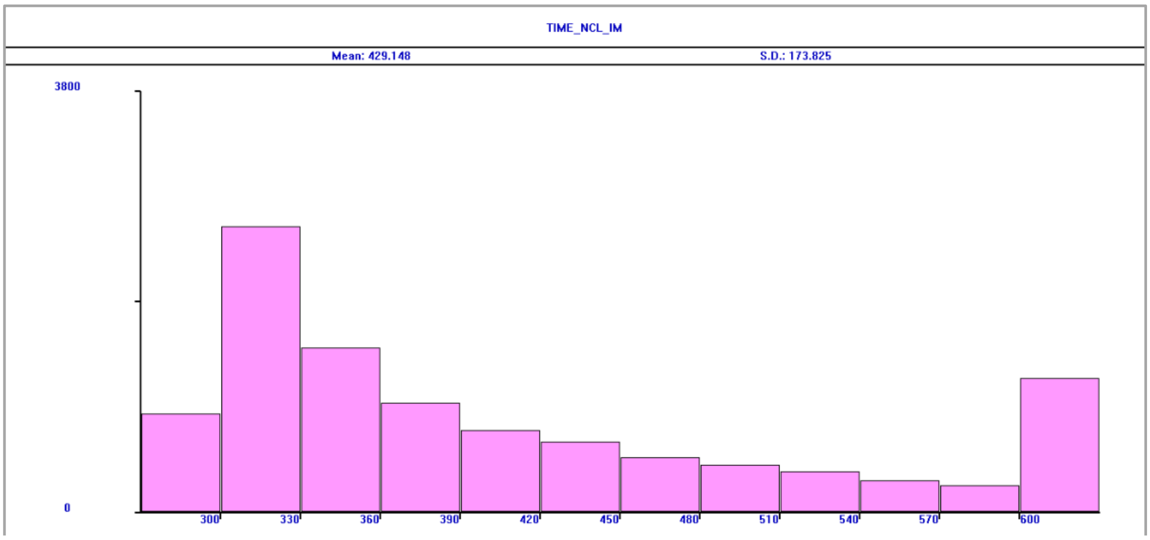


Fig. 13. Distribution of application service time for one-time client (import)

According to the reports obtained as a result of modeling the processing of incoming requests, the main indicators of the simulation results are determined and the amount of time loss of requests for service requests in queues is calculated (Table 3).

Table (3). Main indicators of simulation results

	Output parameters	Client Manager	Lawyer	Planning Department	Transport Department
EXPORT	Average work completion time (min)	90,55	24,397	58,47	101,82
	Average queue lengths for request processing (request)	1,5	0,091	0,77	2,99
	The number of requests served without downtime in the queue (%)	38,94	67,5	57,63	28,77
	Waiting time of the client in the queue (min)	23,55	4,397	7,47	28,82
	Load factor	0,836	0,31	0,79	0,92
	Number of employees to process the request (people)	4,18	0,31	5,55	7,36
	Number of employees in departments (people)	5	1	7	8
IMPORT	Average work completion time (min)	71,47	14,397	69,77	97,37
	Average queue lengths for request processing (request)	0,057	0,091	0,77	2,99
	The number of requests served without downtime in the queue (%)	91,84	67,5	57,63	28,77
	Waiting time of the client in the queue (min)	1,47	4,397	7,47	28,82
	Load factor	0,478	0,31	0,79	0,92
	Number of employees to process the request (people)	2,87	0,31	5,55	7,36
	Number of employees in departments (people)	6	1	7	8

Histograms of waiting time in queues for processing incoming requests from customers for forwarding services are shown in Figures 14 – 16.

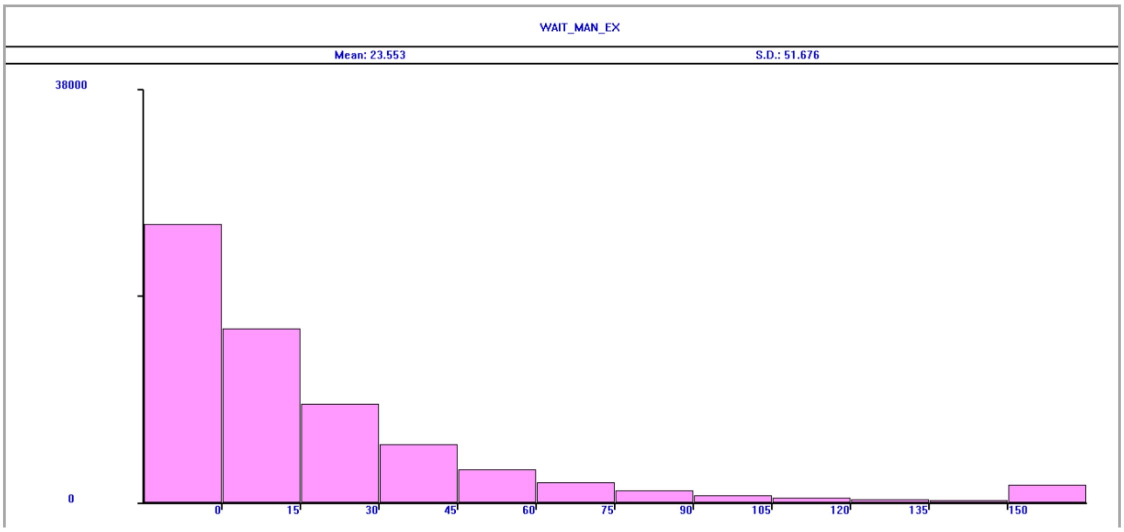


Fig. 14. Distribution of waiting time in the queue of the export request to client manager

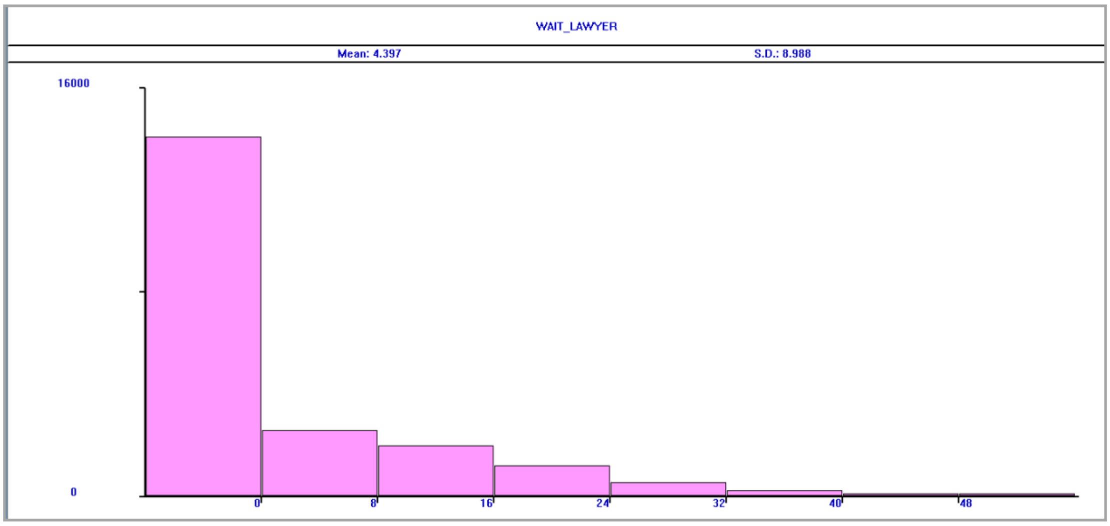


Fig. 15. Distribution of waiting time in the queue of the export request to lawyer

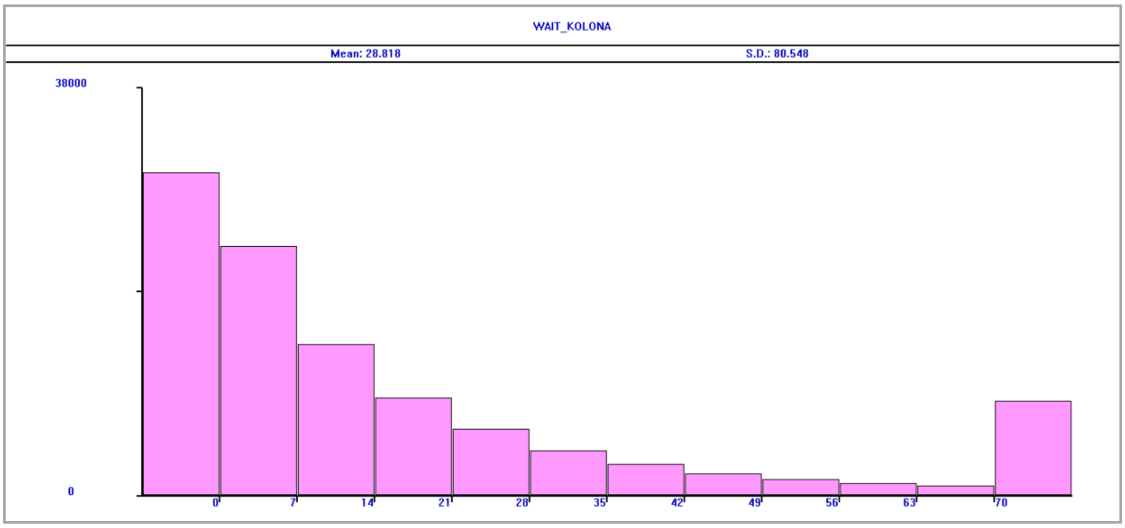


Fig. 16. Distribution of waiting time in the queue of the export request to transport department

Having analyzed the calculation results, we can see that the "bottleneck" for this flow of requests is the number of client managers in the export department and the number of employees in the transport department, the increase of which will increase the throughput and reduce the time of customer service and request processing. While the number of jobs for client managers in the import department can be reduced.

IV. CONCLUSIONS

The developed simulation model can be used to determine the optimal structure of a logistics company in the provision of forwarding services.

In determining the optimal number of employees to work with service consumers, a company's management should take into account the quantitative and qualitative indicators of their activities, but the most important aspect of any logistics organization`s operation is, of course, financial indicators.

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