Sensitivity analysis of a single server finite-source retrial queueing system with two-way communication and catastrophic breakdown using simulation

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CITDS2022, Debrecen, Hungary

Outline

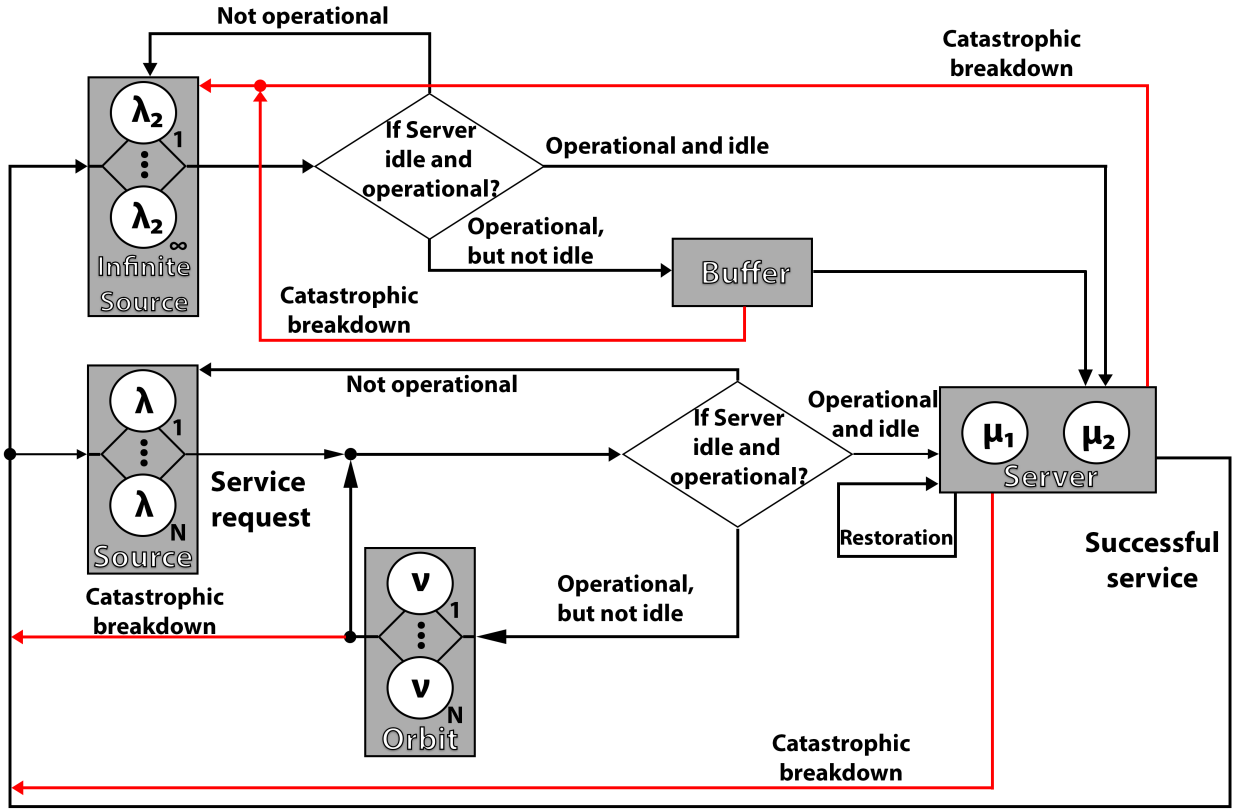

Figure 1: Operation scheme of the system

Ultimate (desired) performance measures

- *Distribution of number of requests in the system, including in service and in orbit*
- *Distribution of number of retrials*
- *Distribution of the response/waiting time of a customer*

Tool supported and algorithmic approaches

- *MOSEL (MOdeling, Specification and Evaluation Language) solution*

- *Algorithmic method*

Simulation approach

- *The effect of distributions of the involved random variables on the distribution of the number of customers in the system*
- *The effect of distributions of the involved random variables on the mean and variance of the response/waiting time of a request*
- *The effect of distributions of the involved random variables on the mean and variance of the number of retrials*

Simulation method

Exponentially distributed failure and restoration times

N	λ	λ_2	μ_1	μ_2	ν	γ_2
100	0.02	0.5	1	2.5	0.01	1

Table 1: Numerical values of model parameters

γ_1	P(departure)
0.00001	0.002113
0.01	0.535419
0.1	0.724697

Table 2: Probability that a primary customer departs because of a catastrophic event

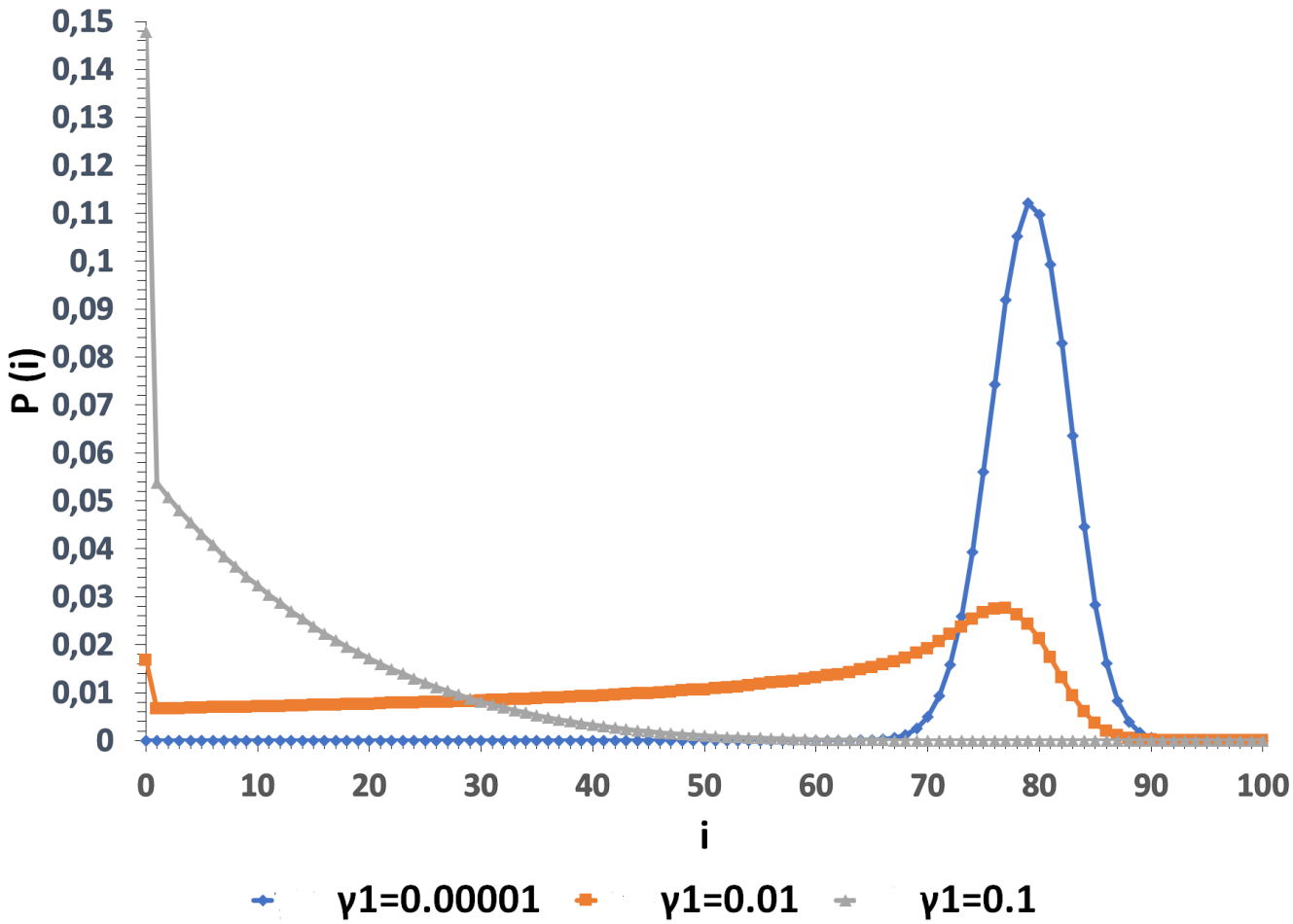

Figure 2: Distribution of number of primary customers in the system

Generally distributed failure time with CV greater than 1

N	λ_2	μ_1	μ_2	ν	γ_2
100	0.5	1	2.5	0.01	1

Table 3: Numerical values of model parameters

Distribution	Gamma	Hyper-exponential	Pareto	Lognormal
Parameters	$\alpha = 0.31225$ $\beta = 0.05588$	$p = 0.3619707$ $\lambda_1 = 0.1295528$ $\lambda_2 = 0.2283569$	$\alpha = 2.145538$ $k = 2.9835251$	$m = 1.0027833$ $\sigma = 1.1981970$
Mean	5.588			
Variance	100			
Squared CV	3.2024857438			

Table 4: Parameters of failure time

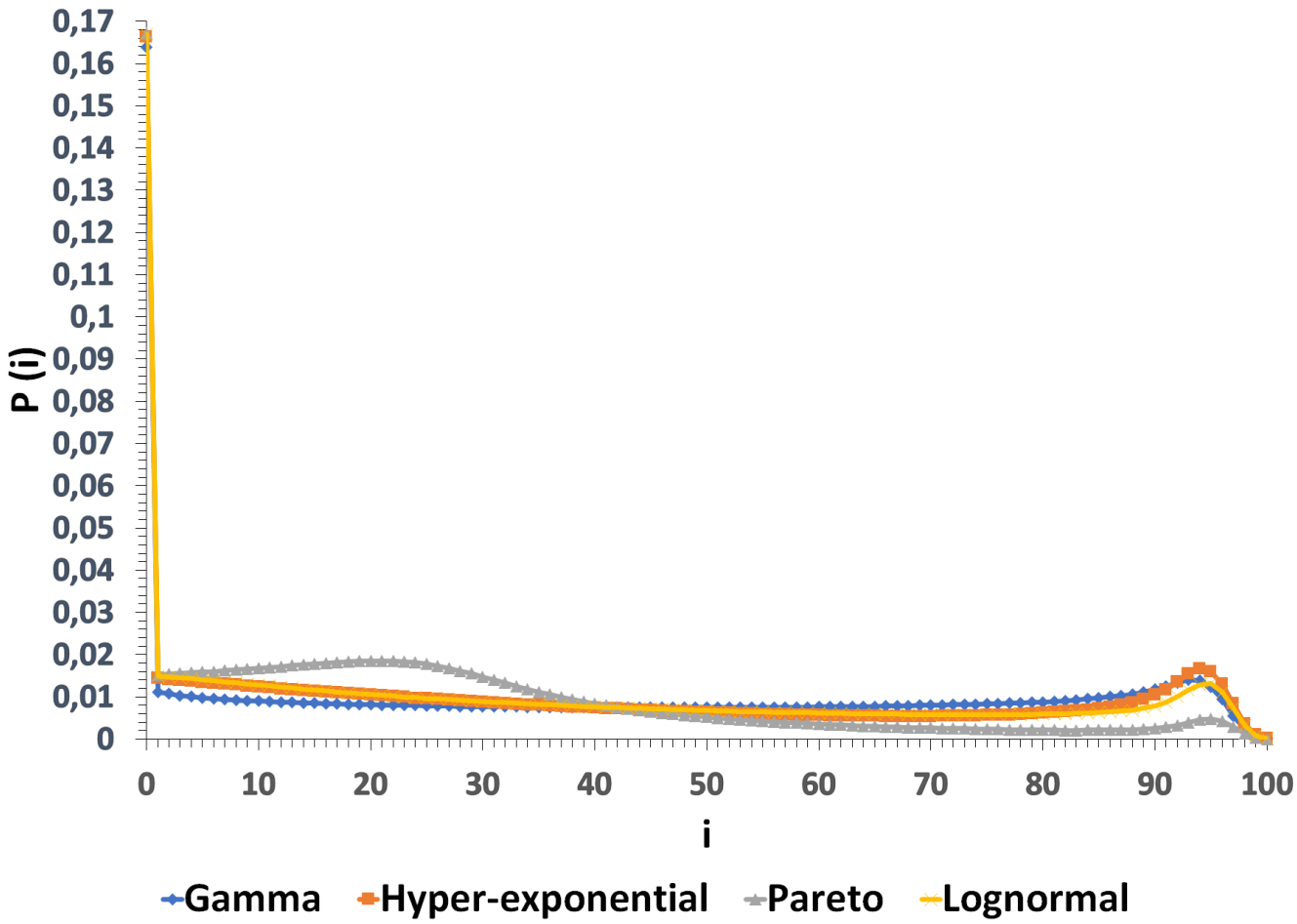

Figure 3: Distribution of number of primary customers in the system, $\lambda = 0.02$

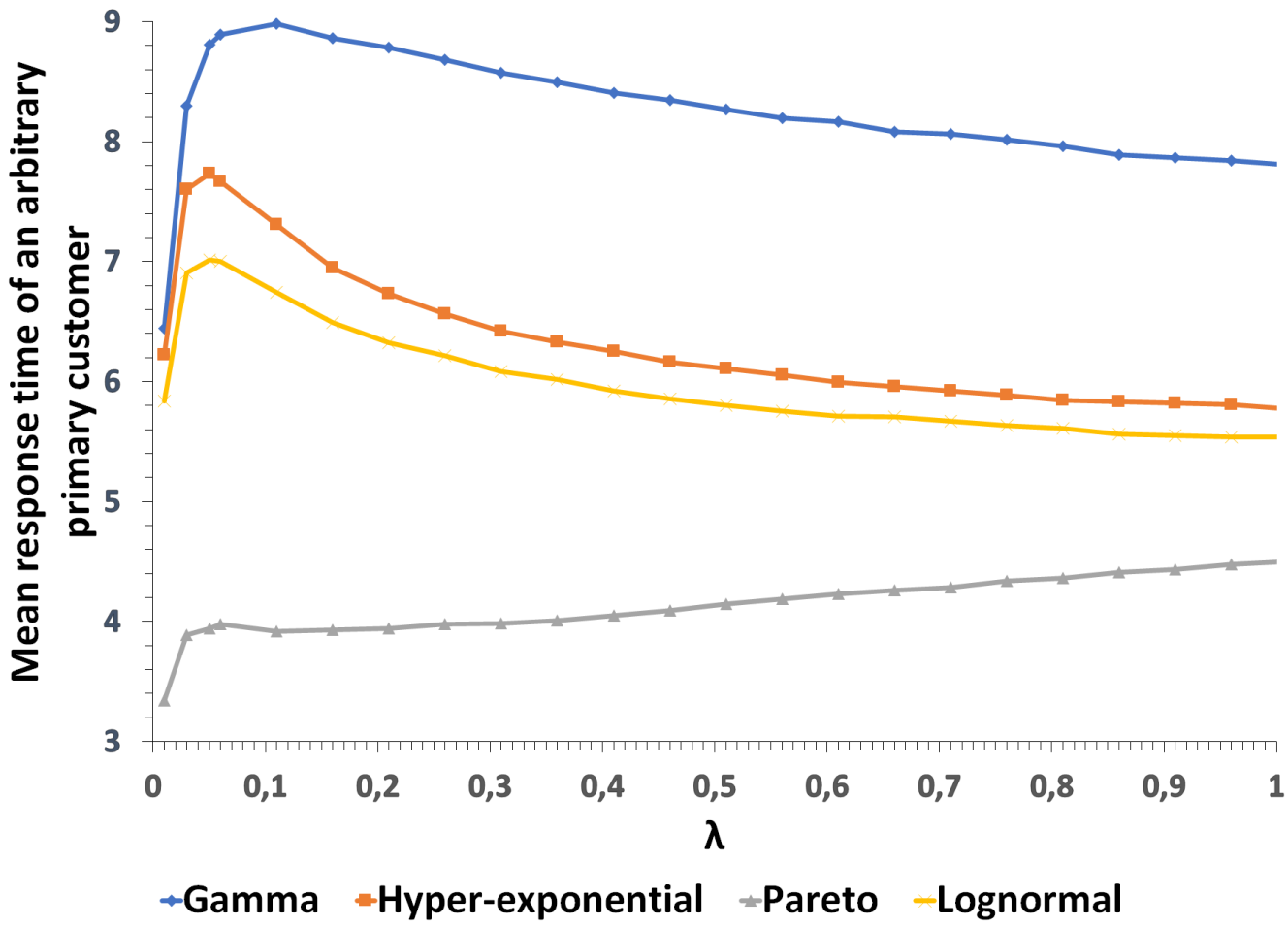

Figure 4: Mean response time of a primary customer

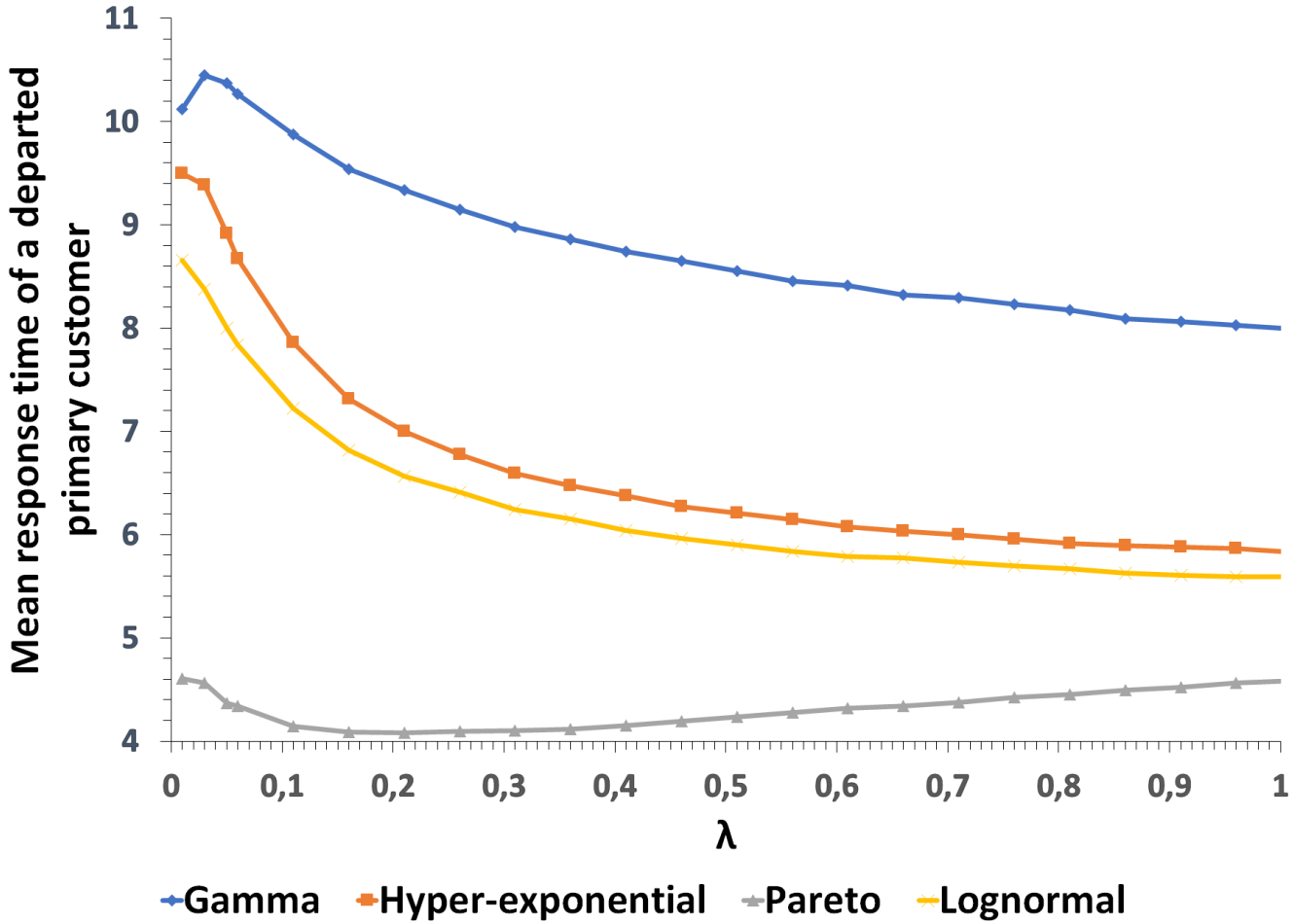

Figure 5: Mean response time of a primary customer without service

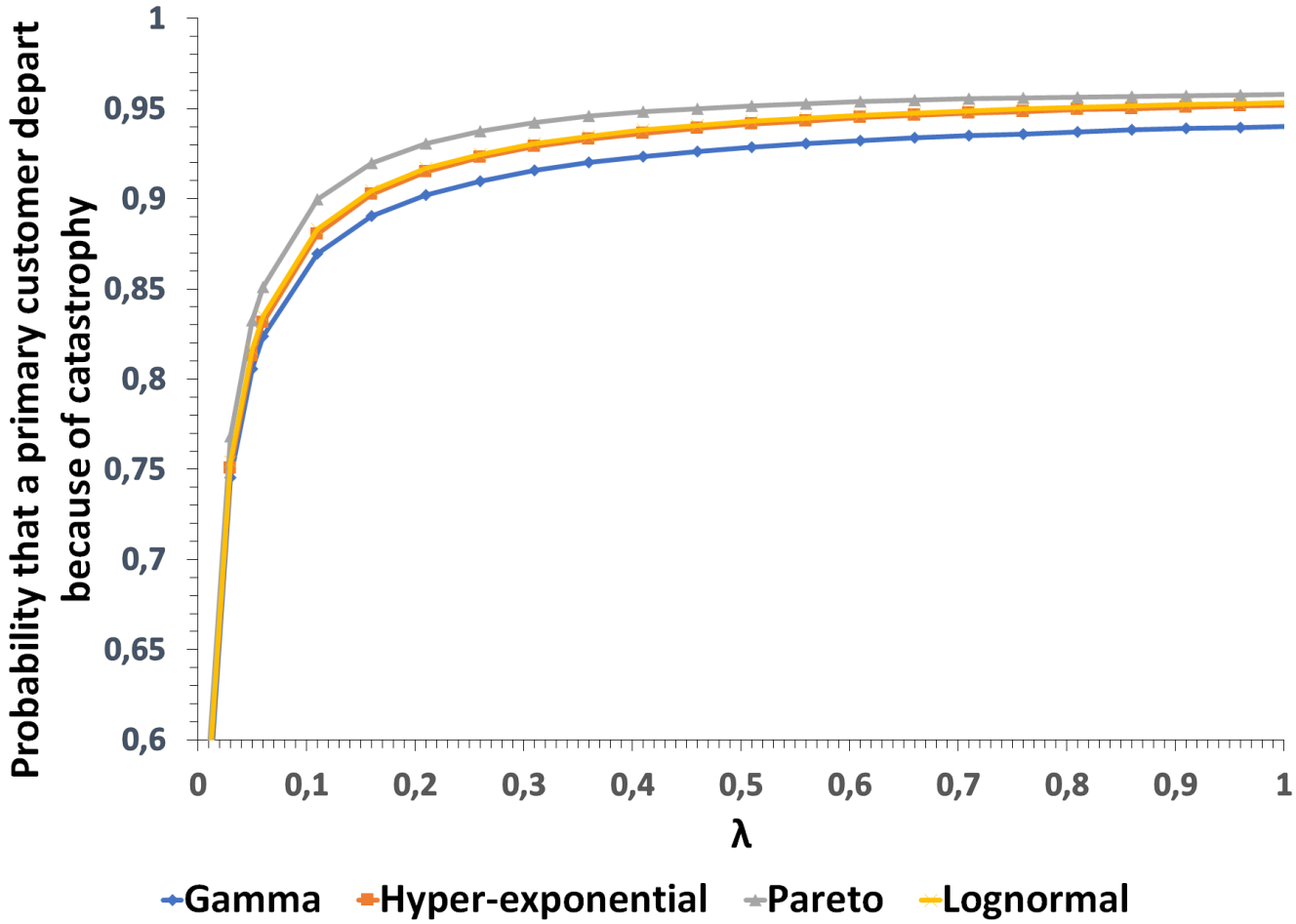

Figure 6: Probability that a primary customer departs

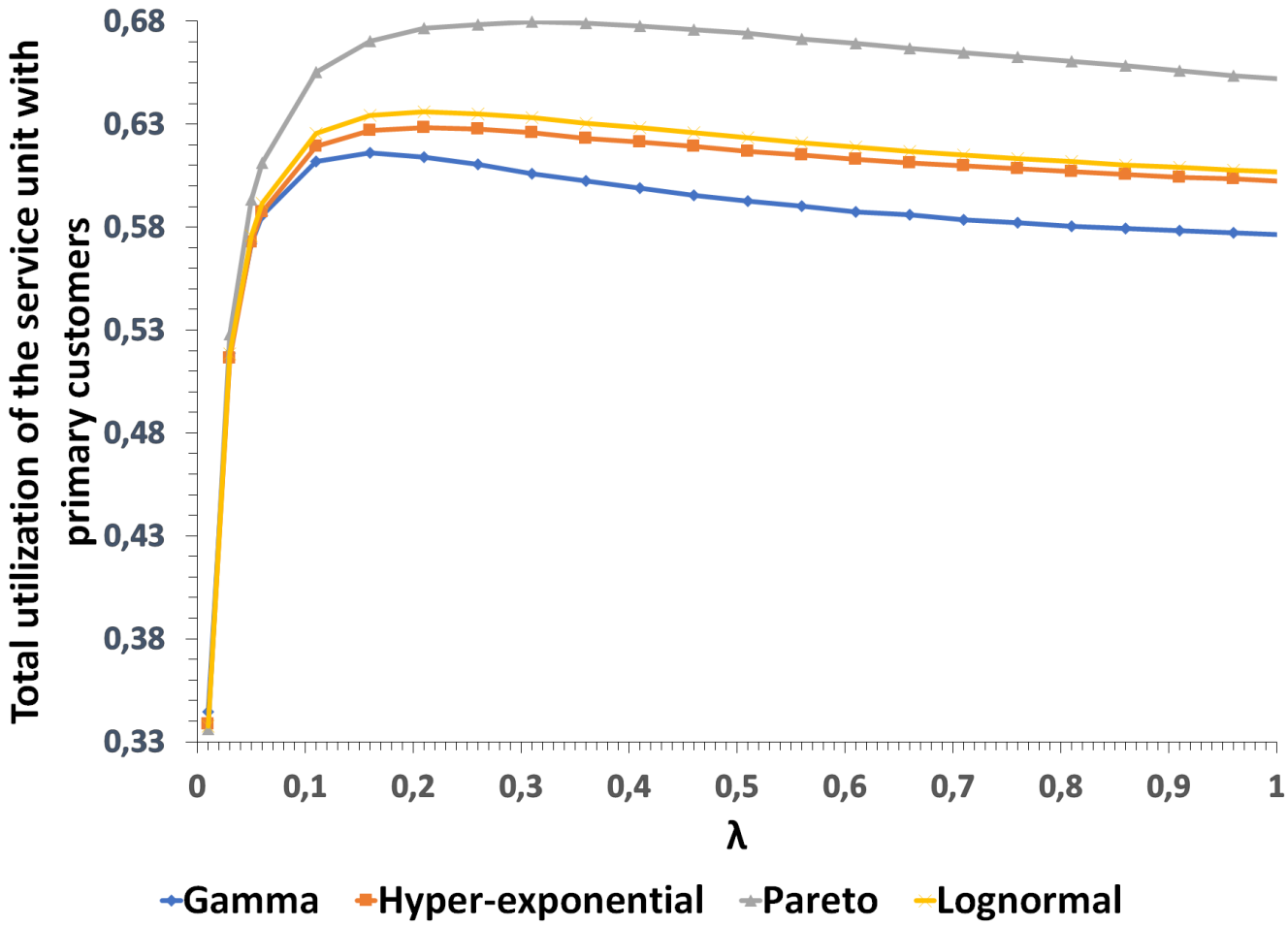

Figure 7: Total utilization w.r. primary customers

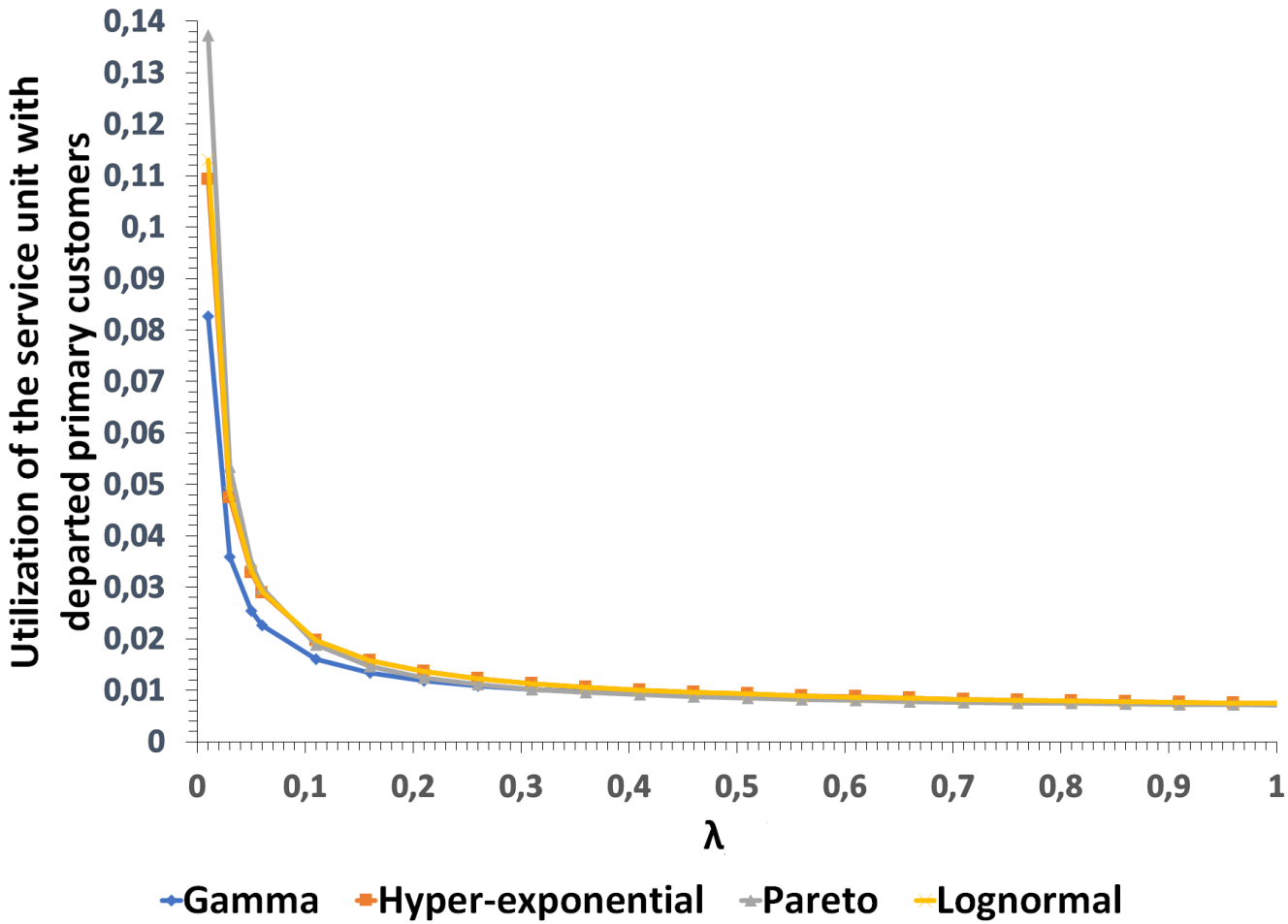

Figure 8: Total utilization w.r. primary customers without service

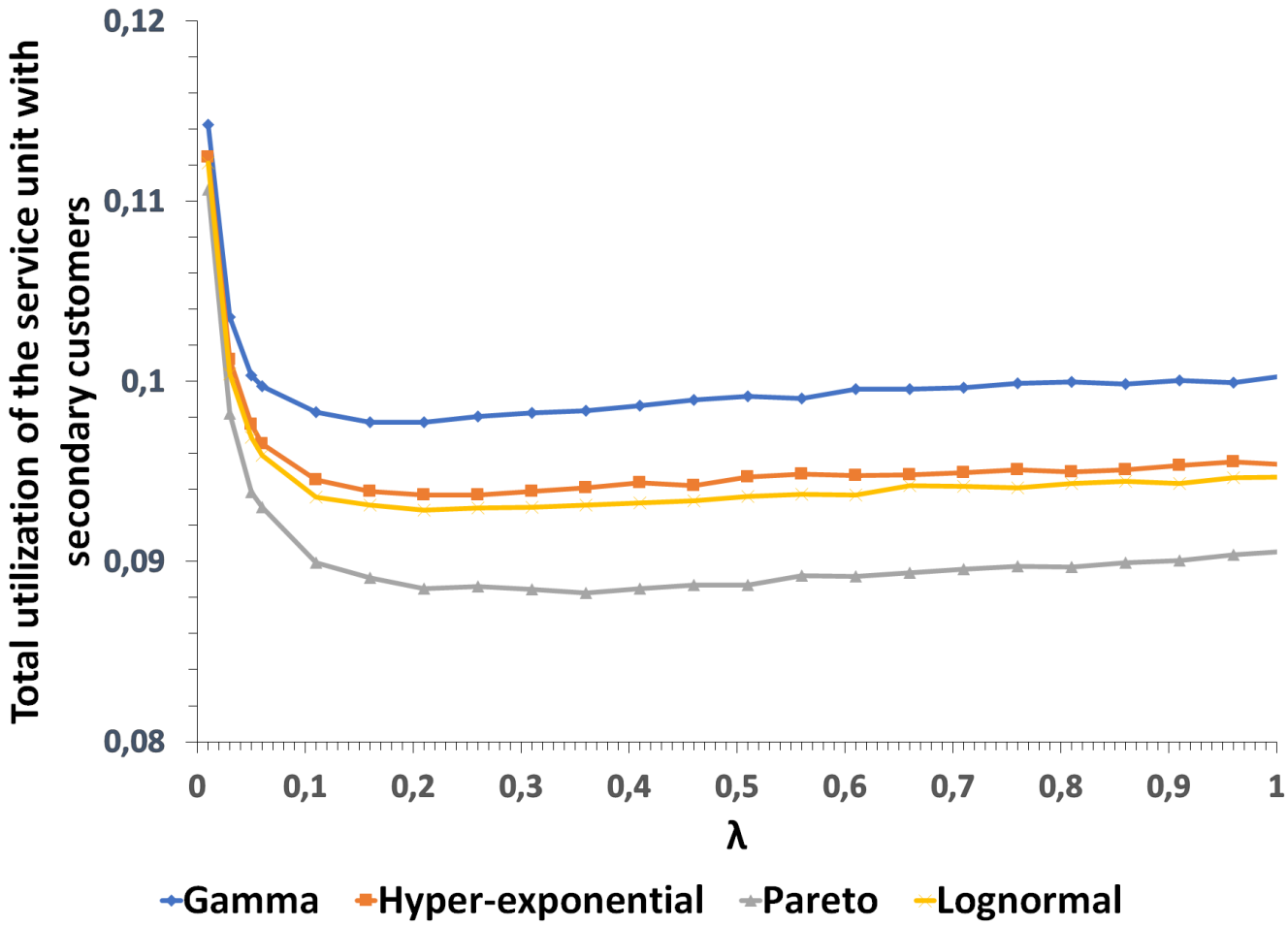

Figure 9: Total utilization w.r. secondary customers

Generally distributed failure time with CV less than 1

Distribution	**Gamma**	**Hypo-exponential**	**Pareto**	**Lognormal**
Parameters	$\alpha = 1.2320819$ $\beta = 0.2204778$	$\mu_1 = 0.2$ $\mu_2 = 1.7$	$\alpha = 2.4940153$ $k = 3.3475773$	$m = 1.423548$ $\sigma = 0.7708627$
Mean	5.588			
Variance	25.3460207612			
Squared CV	0.811634349			

Table 5: Parameters of failure time

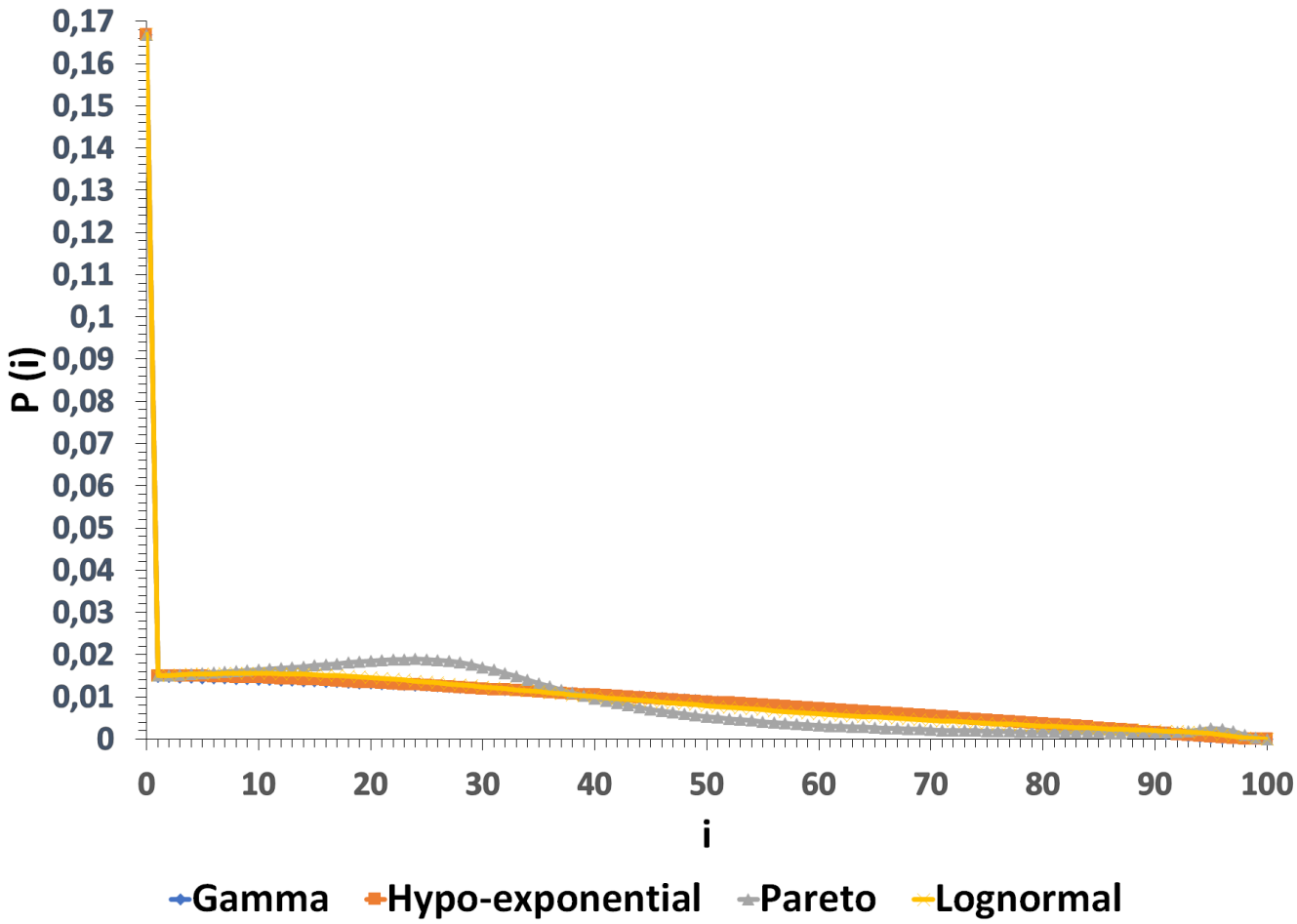

Figure 10: Distribution of number of primary customers in the system

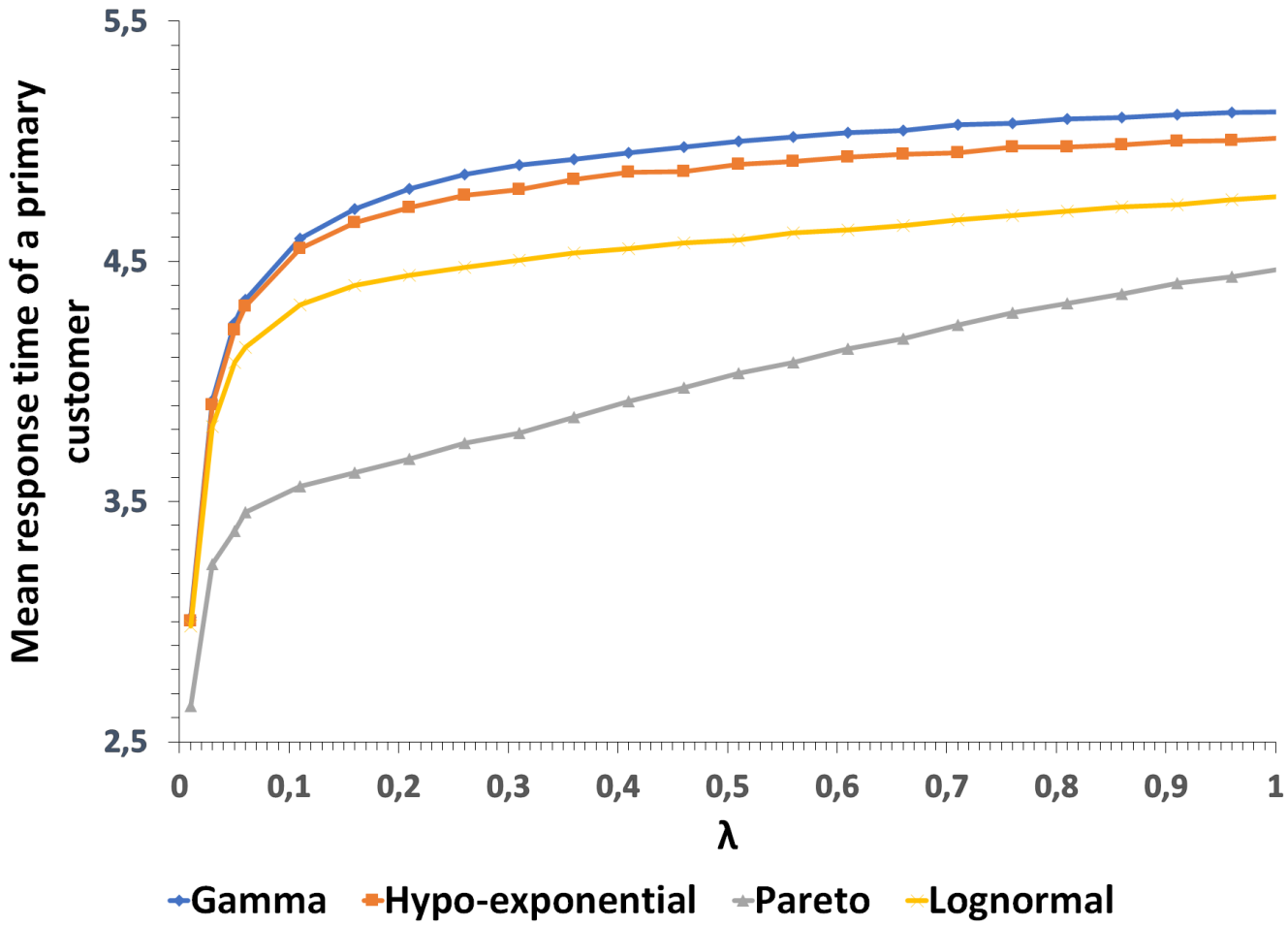

Figure 11: Mean response time of a primary customer

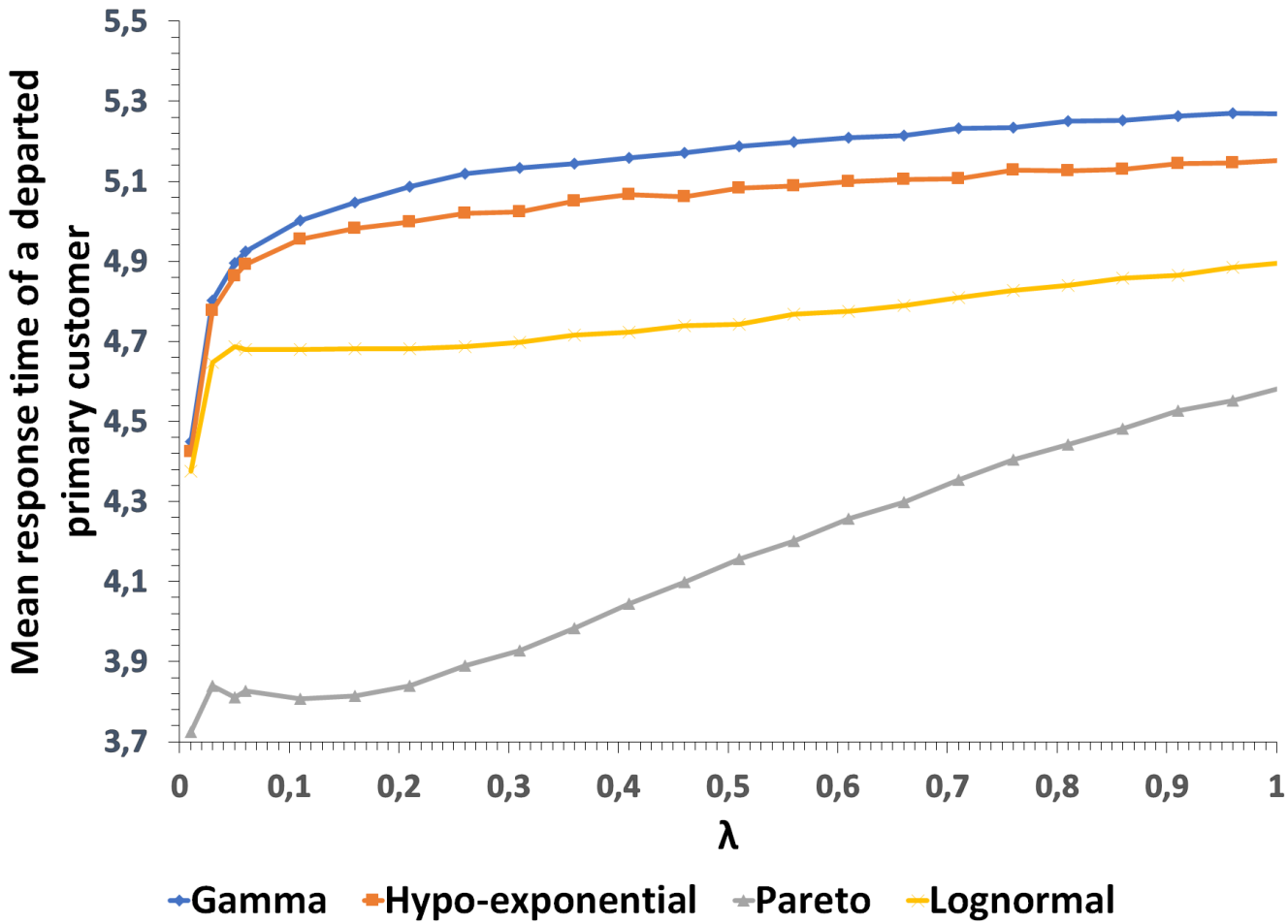

Figure 12: Mean response time of a primary customer without service

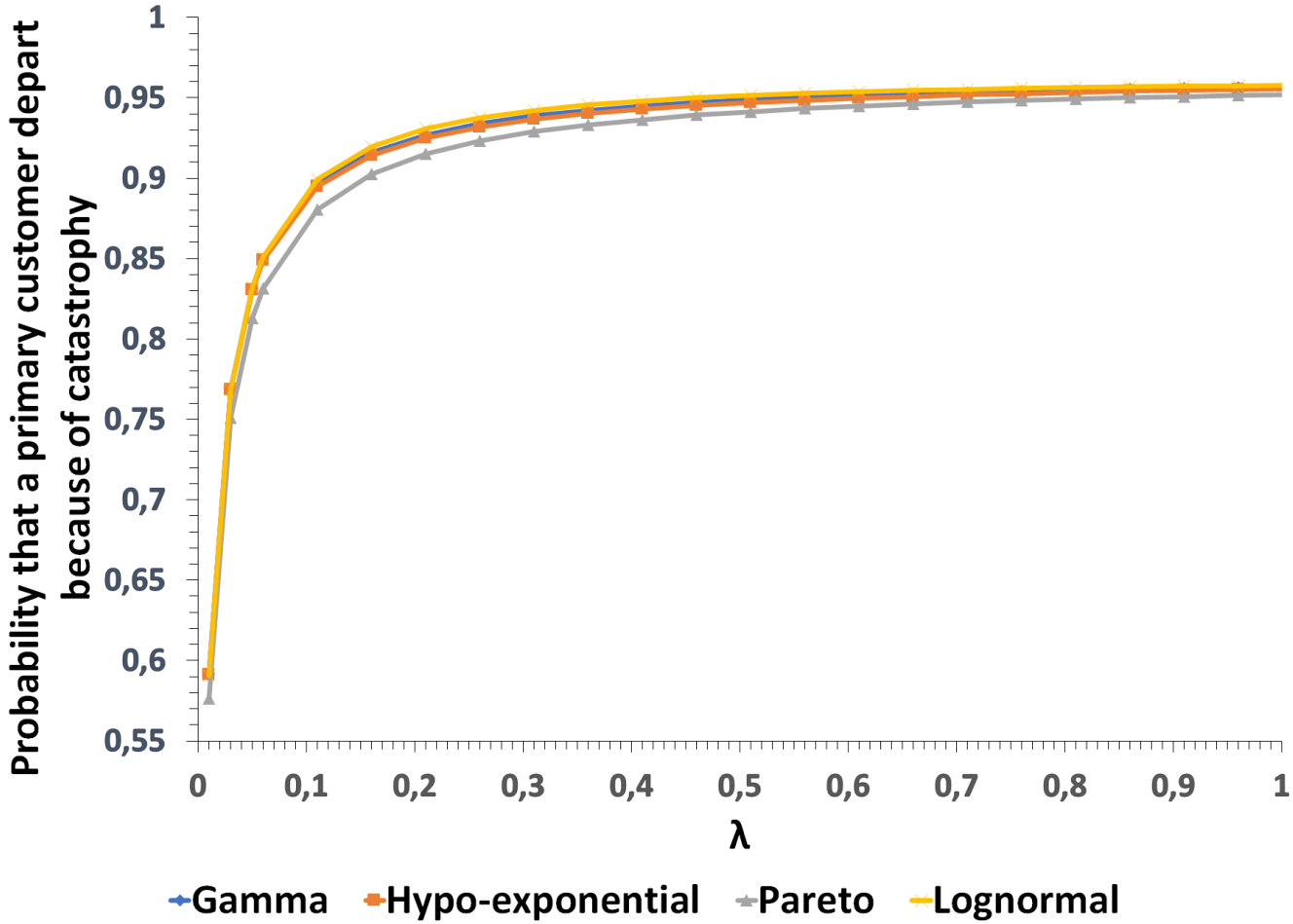

Figure 13: Probability that a primary customer departs

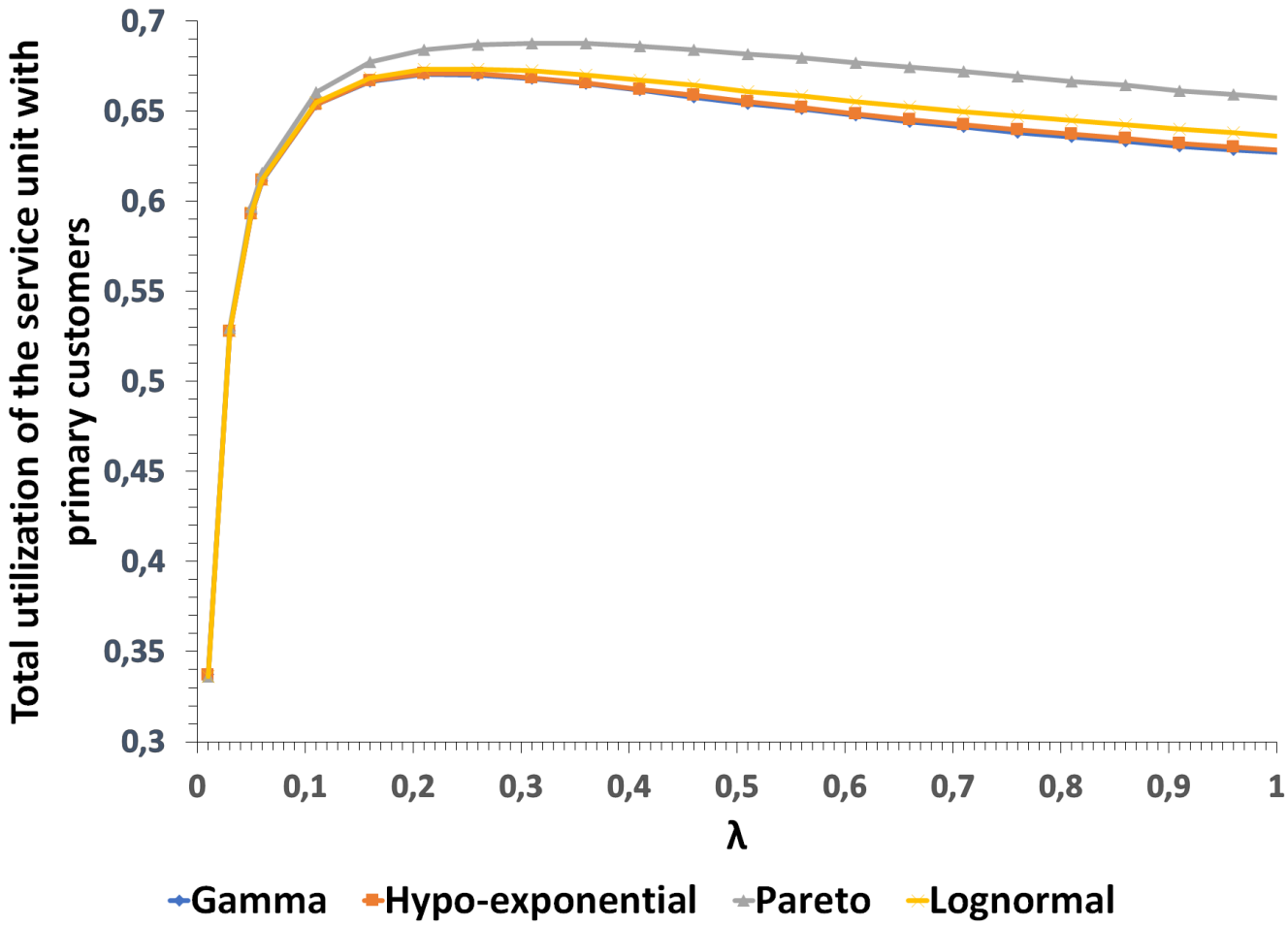

Figure 14: Total utilization w.r. primary customers

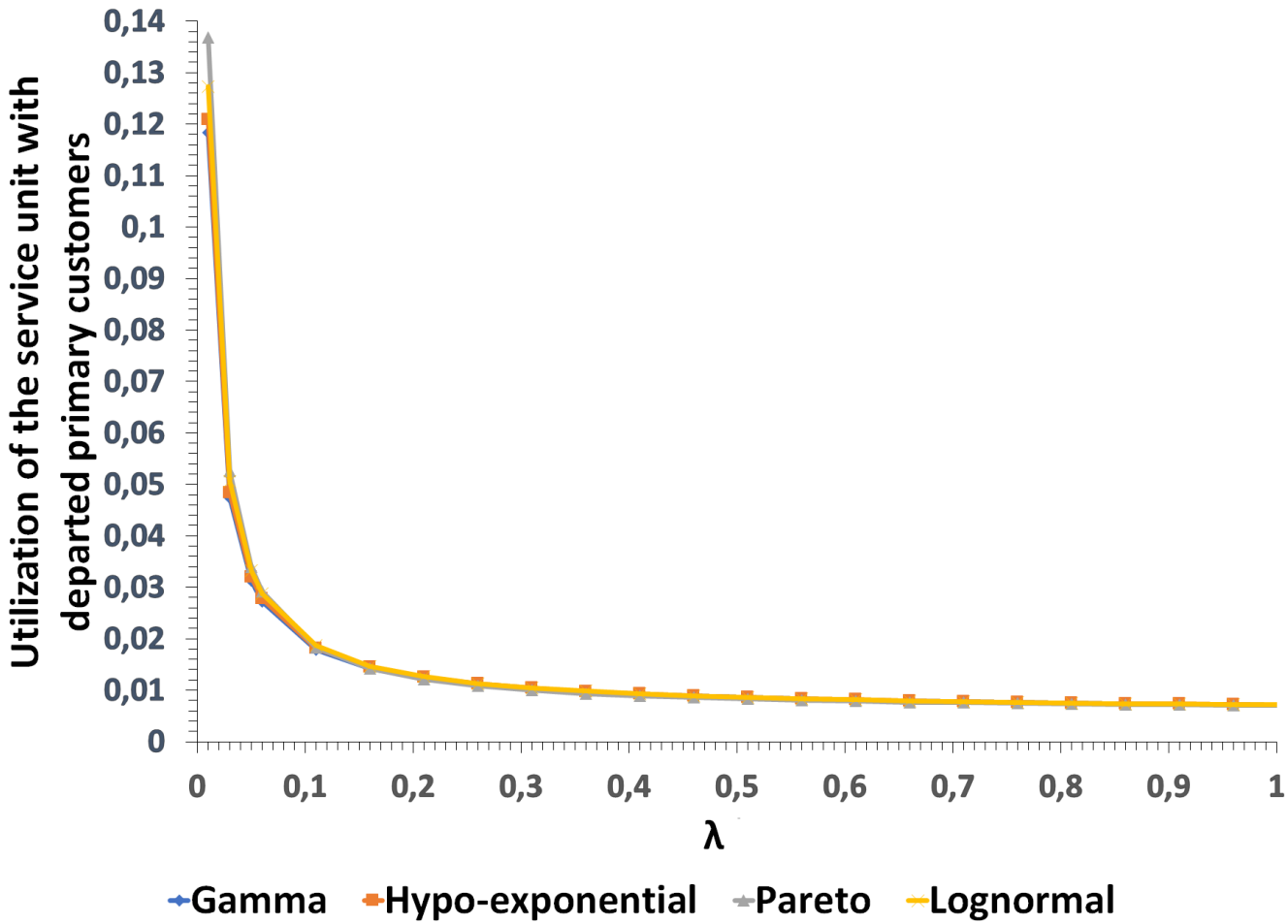

Figure 15: Total utilization w.r. primary customers without service

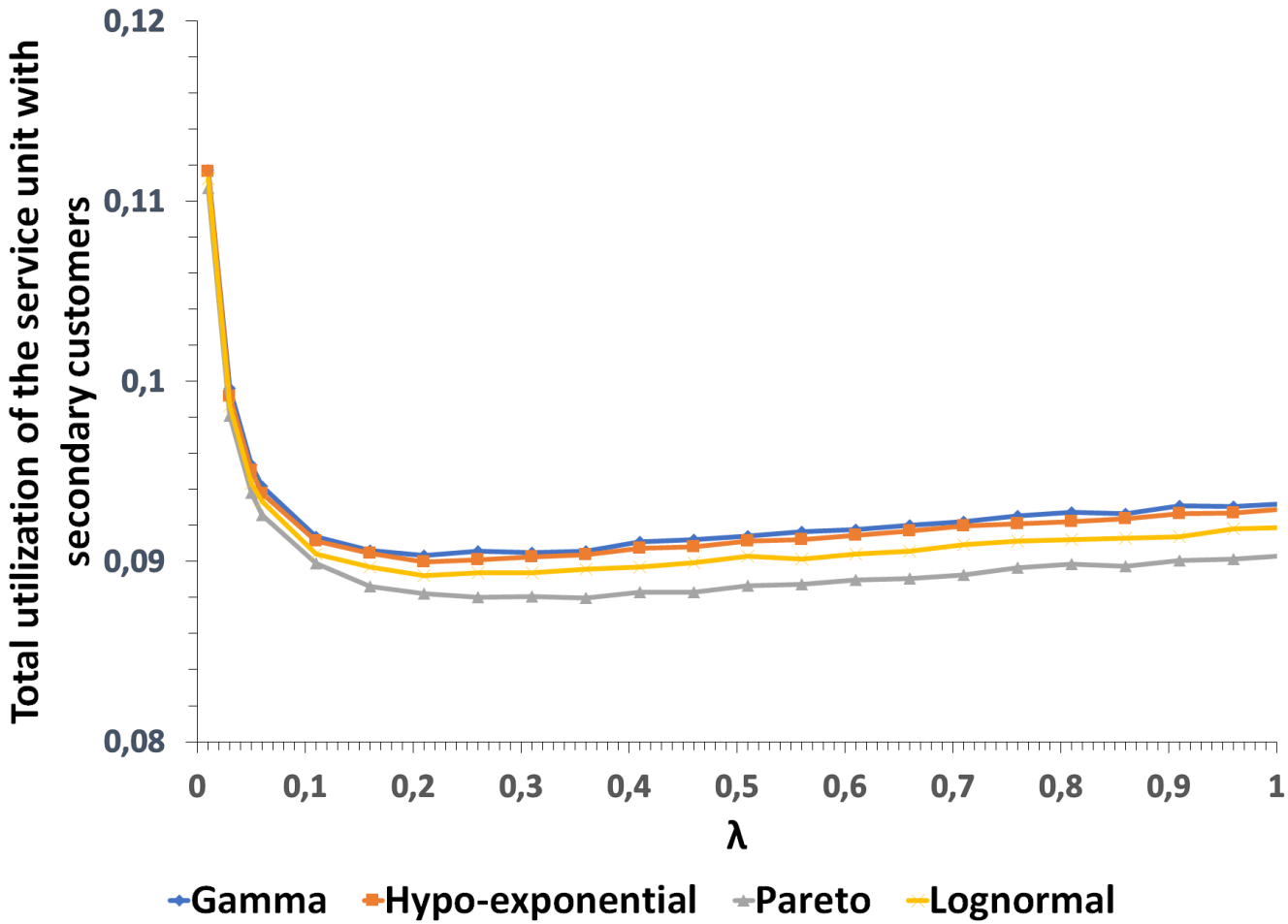

Figure 16: Total utilization w.r. secondary customers

Conclusions

1. Finite source retrial queueing system with two way communication and catastrophic breakdown
2. Simulation approach
3. Graphical illustrations, comparisons
4. Distribution of number of retrials, variance of response times can be obained as well


A. Kuki – T. Bérczes – J. Sztrik
Modeling two way communication systems with catastropic breakdowns,
ITMM 2021, Tomsk, Russia, presentation


A. Nazarov – J. Sztrik – A. Kvach
Asymptotic Sojourn Time Analysis of Finite-Source M/M/1 Retrial Queuing System with Two-Way Communication,
Information Technologies and Mathematical Modelling - Queueing Theory and Applications, Communications in Computer and Information Science vol. 912 (2018), 172-183.


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Reliability Analysis of a Two-Way Communication System with Searching for Customers,
The International Conference on Information and Digital Technologies 2019, IEEE (2019), 260-265.


A. Kuki – T. Bérczes – Á. Tóth – J. Sztrik
Reliability analysis of a retrial queueing systems with collisions, impatient customers, and catastrophic breakdowns,
The International Conference on Information and Digital Technologies 2021, IEEE (2021), 245-259.

Thank You for Your Attention