



Reliability analysis of a finite-source retrieval queueing system with two-way communication and catastrophic breakdown using simulation

J. Sztrik , Á.Tóth, Á.Pintér, Z. Bács

University of Debrecen, Faculty of Informatics

<http://irh.inf.unideb.hu/user/jsztrik>

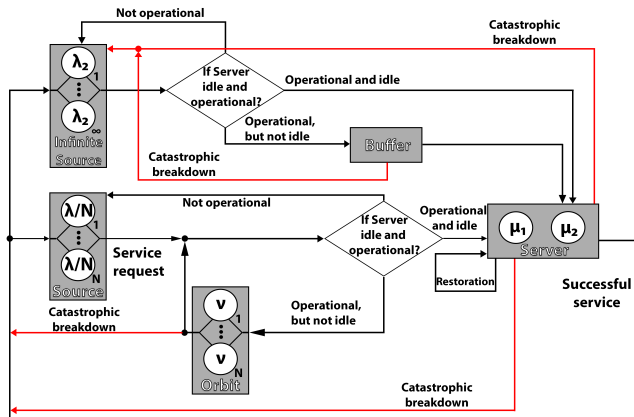
WRQ 2021, Kerala, India

The research was supported by the Thematic Excellence Programme (TKP2020-IKA-04) of the Ministry for Innovation and Technology in Hungary.

Outline

- 1 Finite source retrial queueing systems with two way communication
- 2 Performance measures
- 3 Tool supported, algorithmic and simulation approaches
- 4 Simulation method, comparisons
- 5 Bibliography

Finite source retrial queueing system with two way communication



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

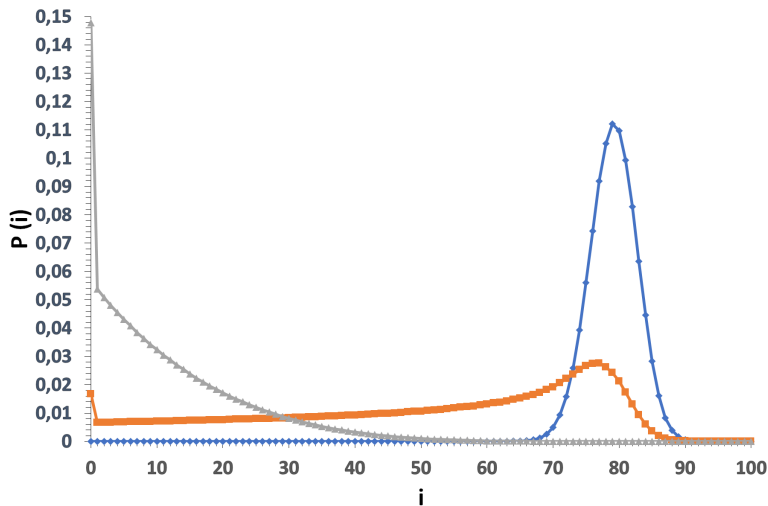
Exponentially distributed failure and restoration times

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

Table: Numerical values of model parameters

$\gamma_0 = \gamma_1$	P(depart)
0.00001	0.002113
0.01	0.535419
0.1	0.724697

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



$\rightarrow \gamma_0 = \gamma_1 = 0.00001$
■ $\gamma_0 = \gamma_1 = 0.01$
■ $\gamma_0 = \gamma_1 = 0.1$

Generally distributed failure time with CV greater than 1

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

Table: 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: Parameters of failure time

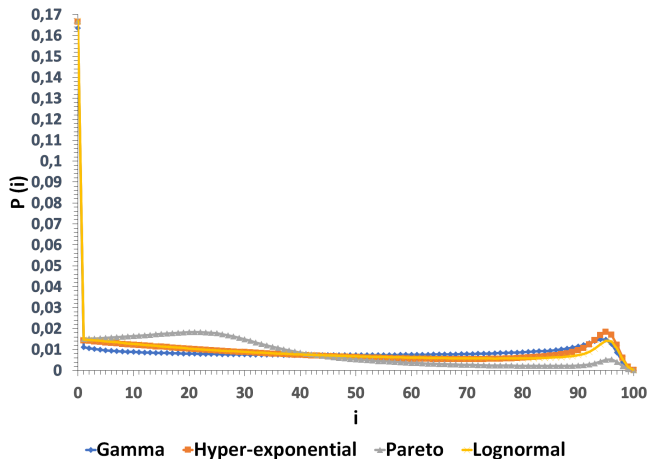


Figure: Distribution of number of customers in the system

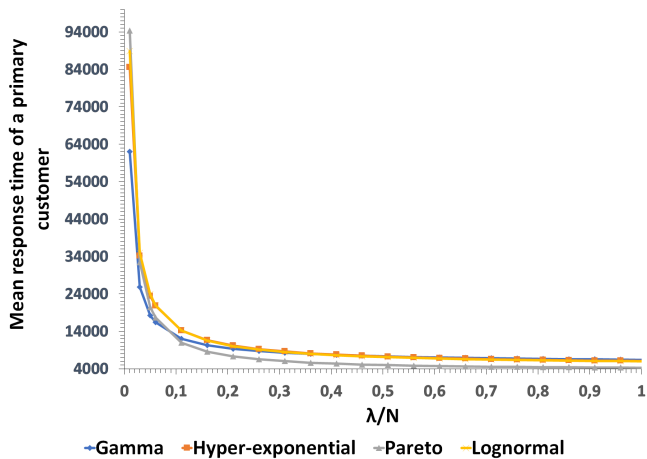


Figure: Mean response time of a primary customer

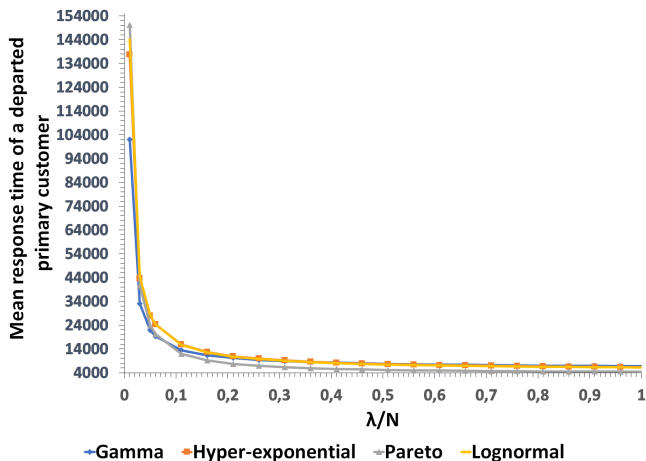


Figure: Mean response time of a primary customer without service

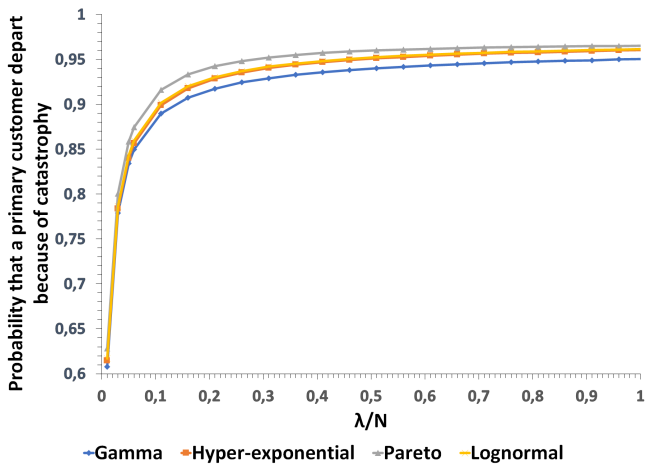


Figure: Probability that a primary customer departs

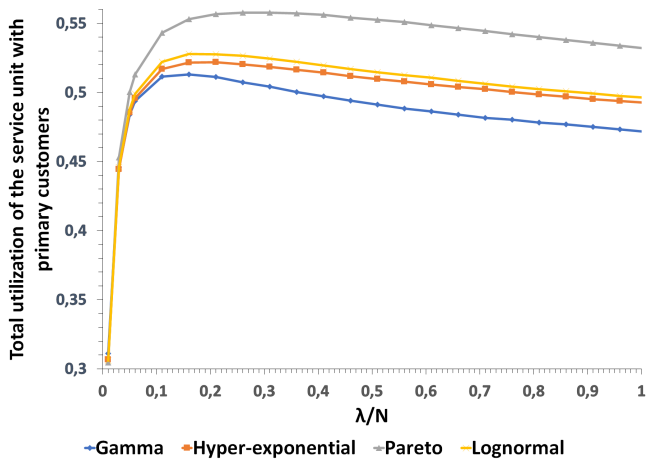


Figure: Total utilization w.r. primary customers

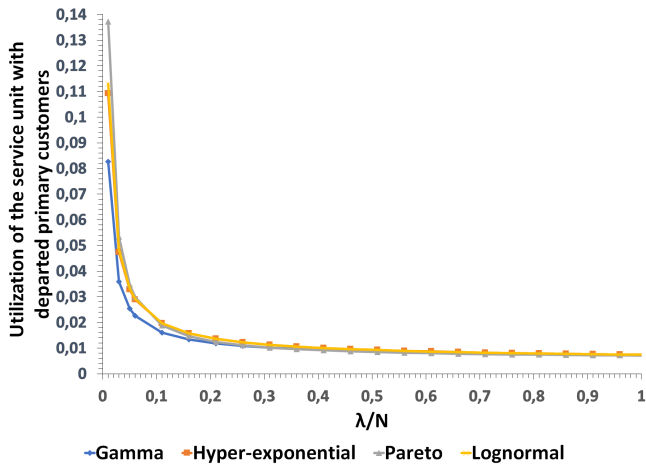


Figure: Total utilization w.r. primary customers without service

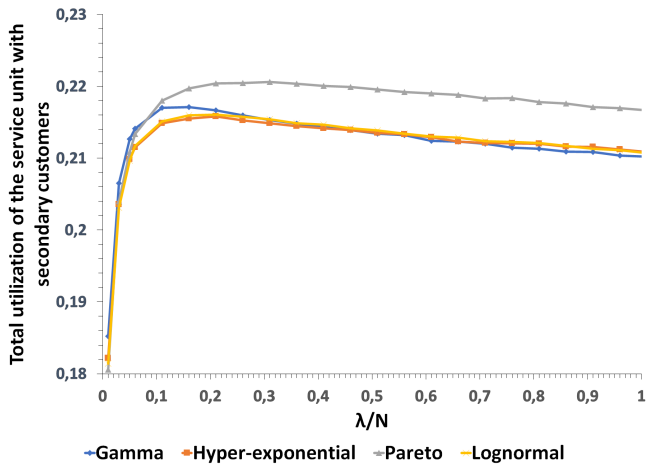


Figure: Total utilization w.r. secondary customers

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: Parameters of failure time

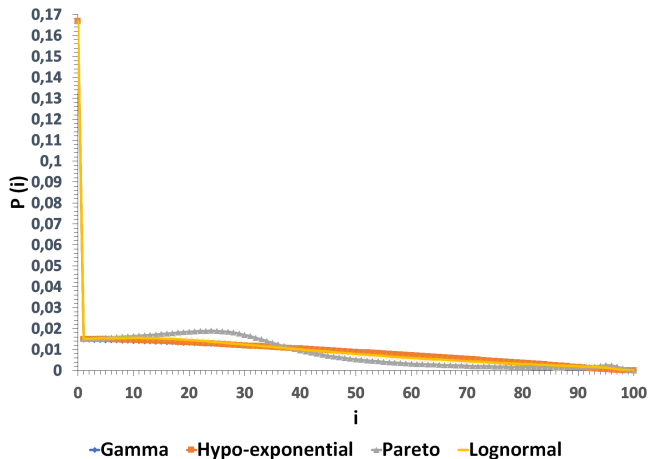


Figure: Distribution of number of customers in the system

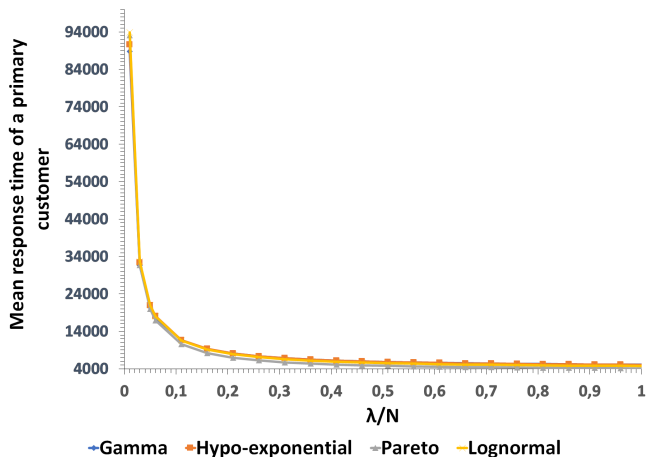


Figure: Mean response time of a primary customer

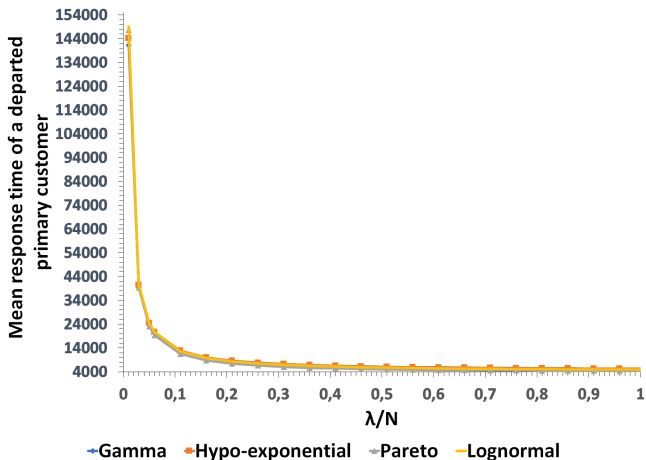


Figure: Mean response time of a primary customer without service

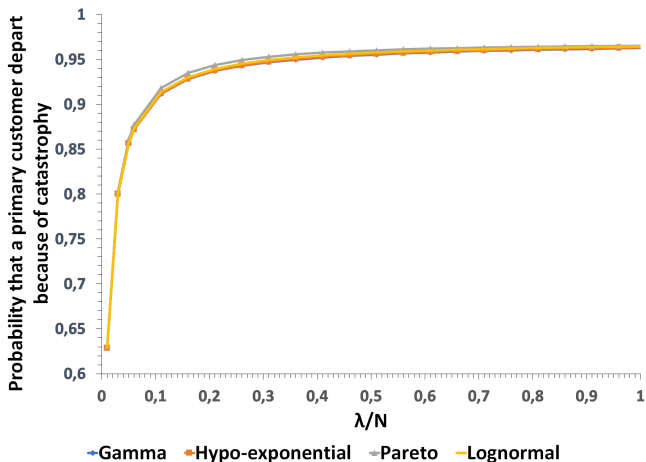


Figure: Probability that a primary customer departs

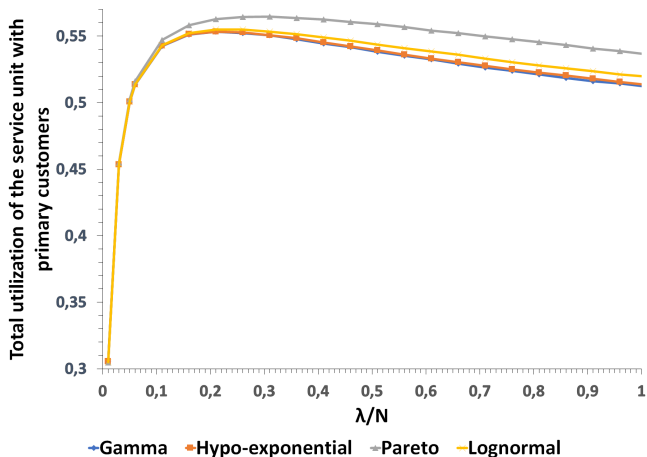


Figure: Total utilization w.r. primary customers

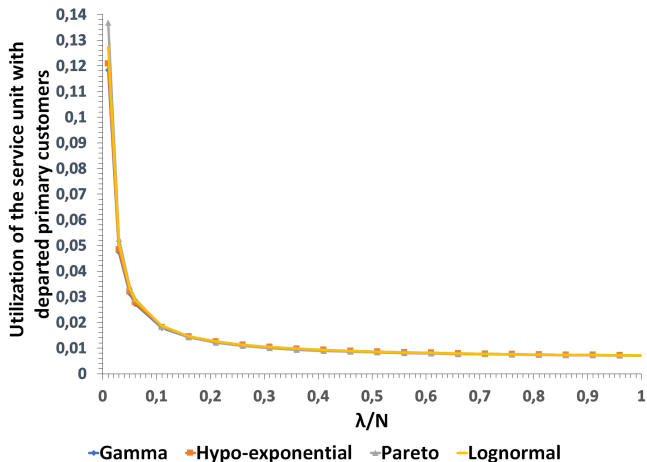


Figure: Total utilization w.r. primary customers without service

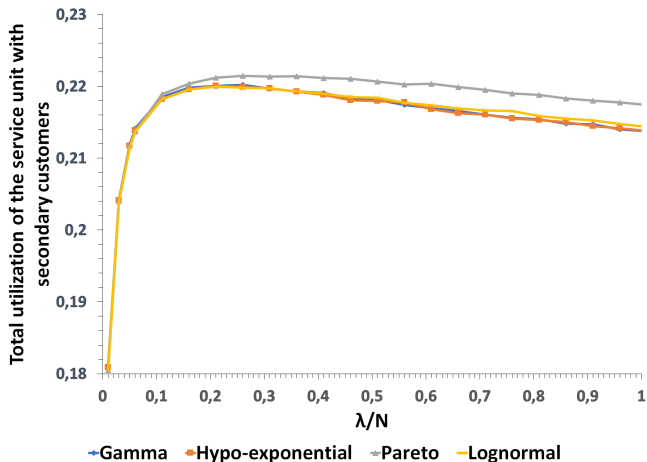


Figure: Total utilization w.r. secondary customers

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 obtained as well




A. KUKI – T. BÉRCZES – J. SZTRIK


Modeling two way communication systems with catastrophic breakdowns,
ITMM 2021, Tomsk, Russia, presentation



A. NAZAROV – J. SZTRIK – A. KVACH

Asymptotic Sojourn Time Analysis of Finite-Source M/M/1 Retrial Queueing 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.

-  A. KUKI – T. BÉRCZES – Á. TÓTH – J. SZTRIK
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*