Stochastic Modelling Report

Ya Kun Kaya Toast at Changi City Point

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INTRODUCTION

Ya Kun Kaya Toast is a household name in Singapore that is synonymous with quality and a cosy meal. With such a reputation, it is doubtless that Ya Kun Kaya Toast has customers streaming in during meal times. Hence, the team decided to study the queueing process and service process at Ya Kun Kaya Toast to further understand how its service system has evolved in response to the current demands.

METHODS

For this study, the team acquired the arrival and service time of each customer via time-motion studies during the lunch peak period (11am - 2pm) at Changi City Point (CCP). Thereafter, inter-arrival time and service time were gathered by running the time-stamp data through @RISK.

RESULTS

Interarrival Time

Mean (mins)	1.3224
S.D. (mins)	1.3776
SCOV (C_a)	1.0417
Mean arrival rate, λ (customers per min)	0.7562

Table 1

Based on the SCOV value and the appearance of the histogram (Appendix, Fig. 1), the arrival distribution is most likely ***exponential*** as the value of SCOV is close to 1 and the actual distribution of interarrival times fits the exponential distribution well. In addition, based on the fit comparison results by @RISK, the exponential distribution gives the lowest AIC (Akaike Information Criterion) values of all the distributions tested, as seen in table 2.

Distribution Tested	AIC Value*
Exponential	301
Pareto2	303
Triangular	366

Table 2

In conclusion, the customer interarrival times are exponentially distributed with a rate of 0.7562 customers per minute.

Service Time

Mean (mins)	1.1715
S.D. (mins)	0.8215
SCOV (C_s)	0.701238
Mean service rate, (customers per min)	0.8536

Table 3

According to the histogram (Appendix, FIg. 2), the service time distribution has a close resemblance with the exponential distribution. However, the service time has a SCOV value far from 1. Thus, the team decided to model the system as an M/M/1 queue and an M/G/1 queue to find out which model gives results closer to the actual data.

The average time spent in the system from the time stamp data is **7.93** minutes.

ANALYSIS

Modelling as M/M/1 Queue

In the M/M/1 model, the average long run time that a customer spends in the system can be acquired by the formula, $W_{M/M/1} = \frac{1}{\mu-\lambda}$. Using the values of   and λ, the calculated average time spent in the system is **10.27** minutes.

Modelling as M/G/1 Queue

In the M/G/1 model, the average long run time that a customer spends in the system can be determined from the formula, $W_{M/G/1} = \frac{1}{\mu} + \frac{\lambda(1+C_s)}{2\mu^2(1-\rho)}$, where $\rho = \frac{\lambda}{\mu}$. Using the values of , λ and C_s, the calculated average time spent in the system is **8.91** minutes.

CONCLUSION

Service Distribution

By observing the calculated average time spent in system for both the M/M/1 and M/G/1 models, the team concluded that the M/G/1 model is preferable to M/M/1 model as M/G/1 model gives a value closer to actual value. Thus, it is better for service time to be modelled as a ***non-exponential*** distribution.

Differences to Actual Data

However, calculations from the queuing models still do not reach the actual value of time spent in system. This could be due to the assumptions that arrival and service times are truly random. In reality, this may not be the case as servers get tired or perform tasks differently based on individual decisions. In addition, the mean arrival and service rates are constantly changing throughout the 3-hour period of the study. This is different from the theoretical queuing model which assumes a constant inter-arrival rate and service rate.

APPENDIX

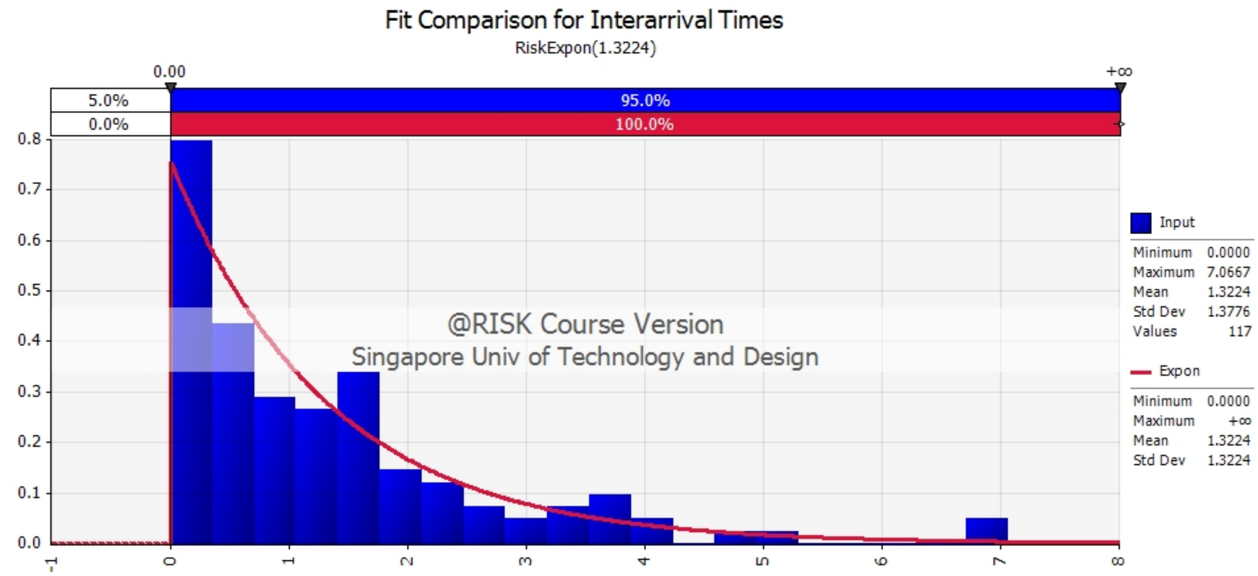

Figure 1

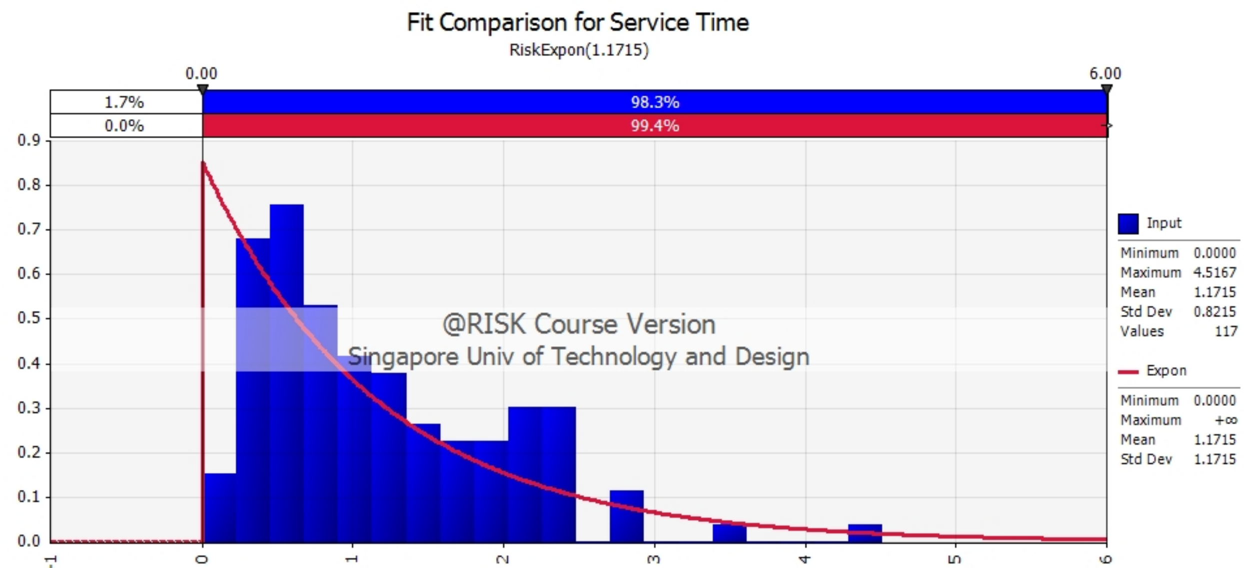

Figure 2