Filippo Guggino, Riccardo Mancini, Zaccaria Essaid

Faculty Bar

Analysis of a faculty bar through simulation

TABLE OF CONTENTS

Problem Description

In the bar there is a **cashier** and a **kitchen**. All orders go through the cashier at first, then some of them exit directly while others, called **compound,** need to be serviced from the kitchen too. Furthermore, there are two types of customers: **VIP** and **normal**. The former have **priority** over the others at the cashier.

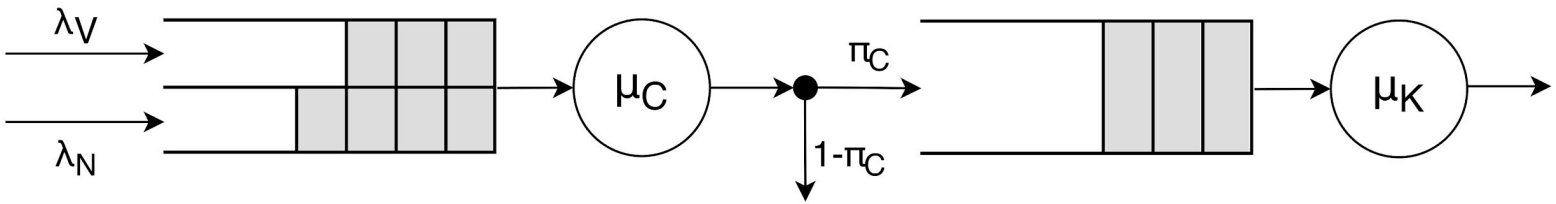
Objectives:

- relationship between the **service times** and the overall experienced **response times**.
- **advantages**, in terms of response time, of being a **VIP** customer.
- **advantages** and **disadvantages** of introducing **priority** head-of-line queueing also in the **kitchen**.
- “optimal value” for the **percentage of VIP customers**. It should provide waiting time **benefits to VIPs without disrupting** the experienced waiting time of **normal customers**.
- show that **queue lengths** only depend on the **service rate** of their server.

Model

The **cashier** is modeled as a service center with priority queueing with two priority classes: VIP and normal. Orders are then fed to the kitchen with a probability π_C (representing **compound orders**), which serves them in a FIFO queue.

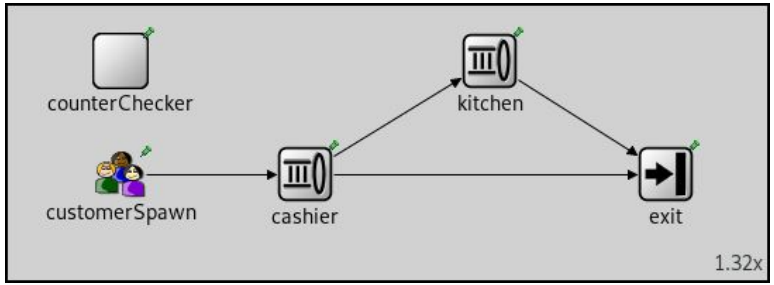
A **stochastic model** for the mean response and waiting times can be written for the model below, if inter-arrival and service times are **exponential**. Said model was used to **verify the simulator code**.



Implementation

The model was implemented in **Omnet++** using 4 nodes + 1 **counterChecker** node to check that no order gets lost. the **cutomerSpawn** generates the orders; the **cashier** and the **kitchen** are the to SCs; the **exit** collects statistics and disposes of the orders.

Verification was carried out by checking against the **stochastic model**, when present, otherwise only continuity and consistency checks were made.



2kr Analysis

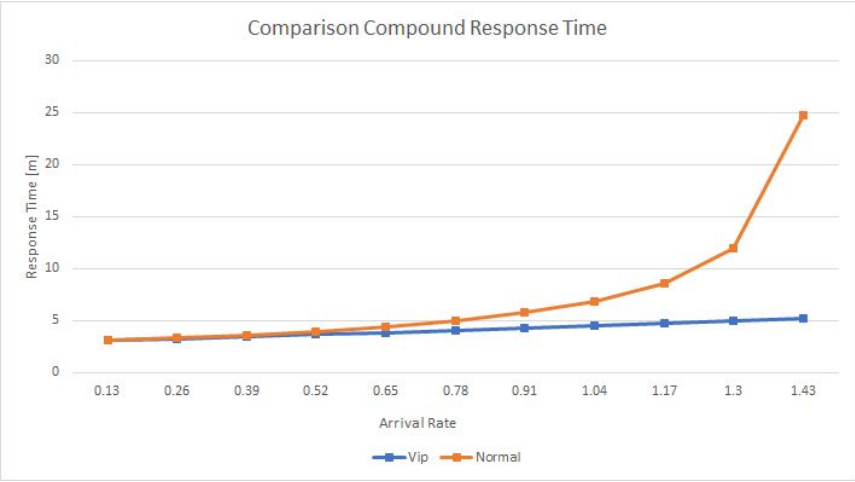
The most interesting results of the analysis are the following:

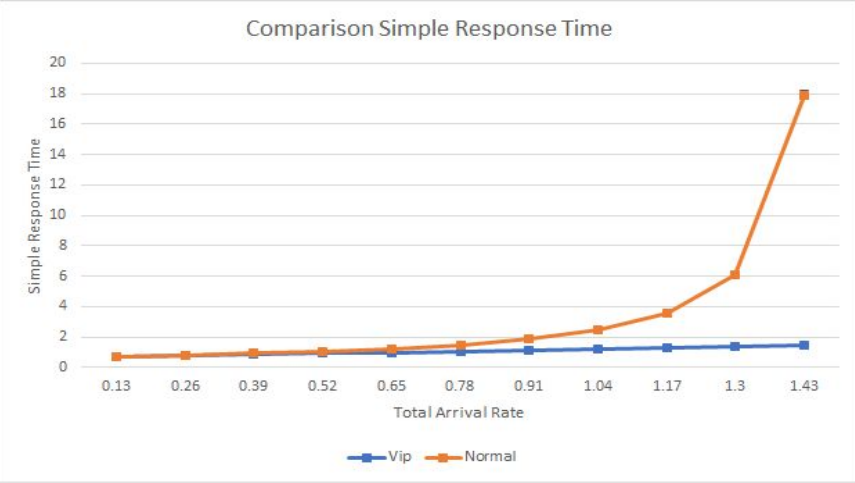
- cashier rate has a **negative impact** on the advantage of VIP orders
- Normal customers rate has a **negative impact** on the advantage of VIP orders

We also visually checked the residuals' hypotheses in order to ensure significance of the results.

Response to different workloads

Establish **threshold** of Customers Arrival Rate
before “explosion” of Normal Response Time.

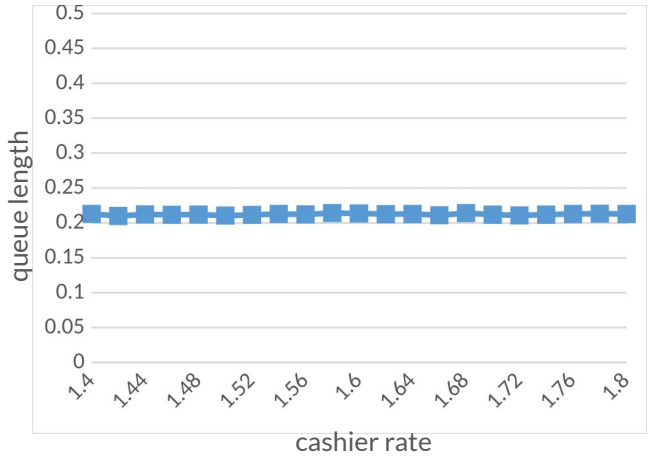




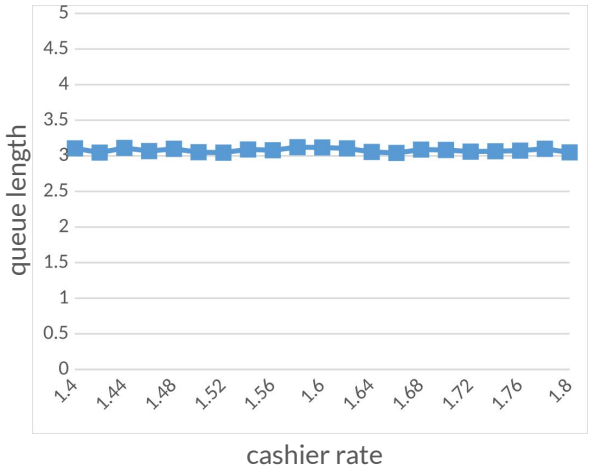
Queue lengths vs service rates ratio

To demonstrate the **independence** of the average queues length with respect to the ratio of the service rates we let the cashier rate vary from 1.4 to 1.8

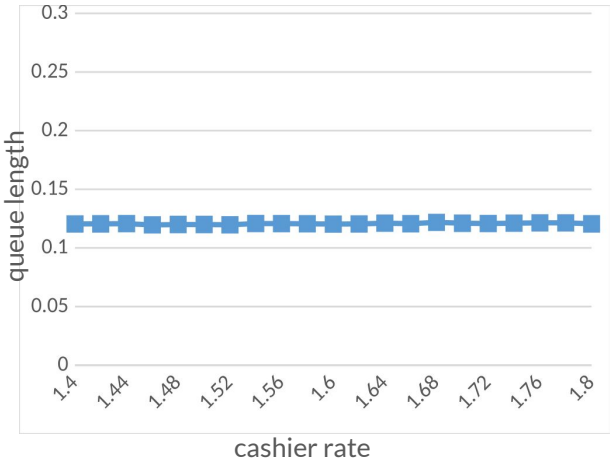
FIFO kitchen



normal customers, priority kitchen



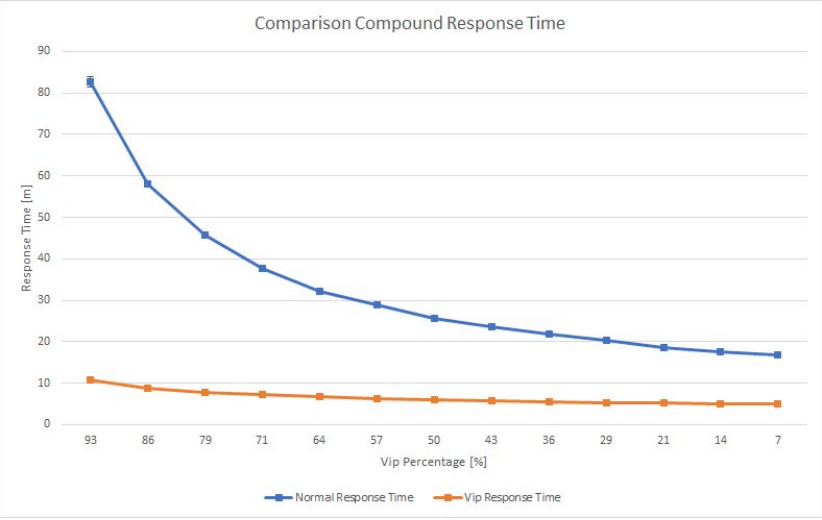
VIP customers, priority kitchen

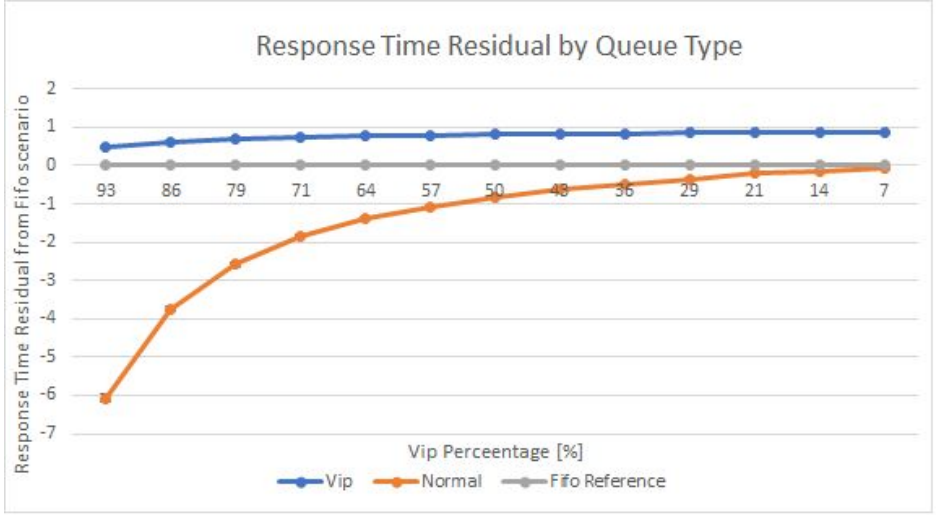


Vip Rate Study

Reasonable response Time for Normal users
Privileged services for VIP users

On the **left**, VIP and normal customers' response time are compared by varying VIP percentage(compound orders).
On the **right**, highlights of differences, in terms of response time, from the FIFO scenario(simple orders).

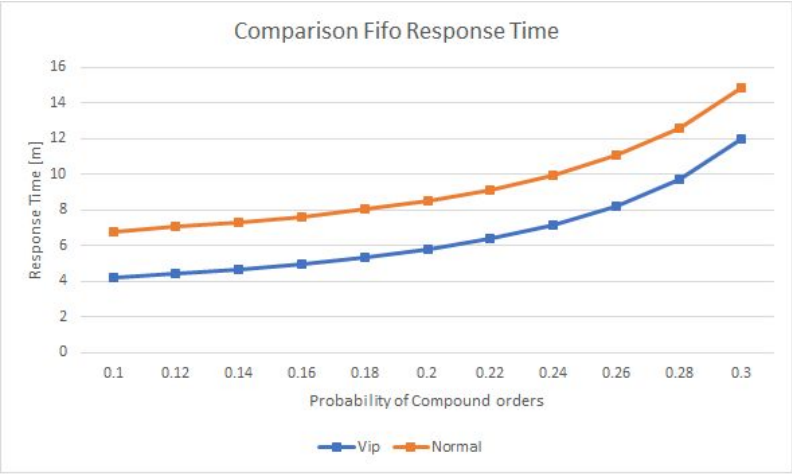


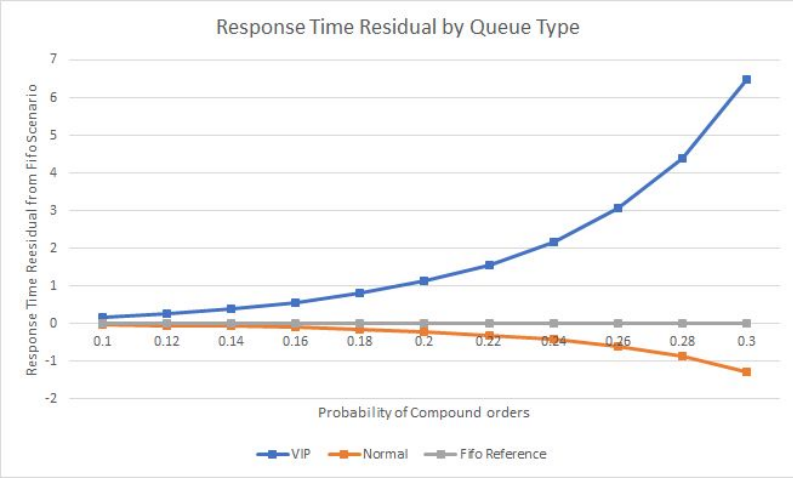


Priority Queue in the kitchen

Vip **advantage** from Cashier service lasts even in the kitchen.

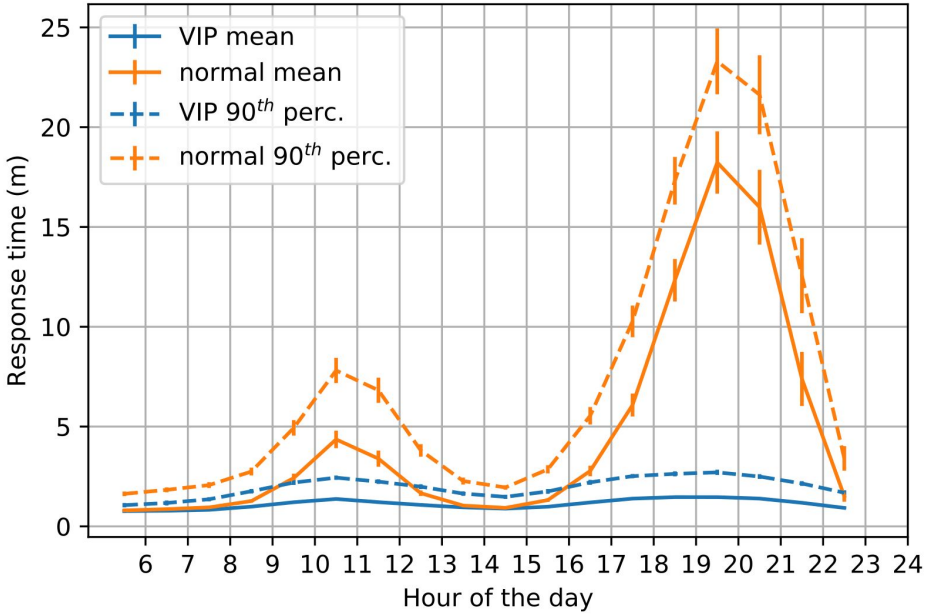
Due to **few VIP users** coming into the kitchen, Normal Response Time doesn't degrade that much.

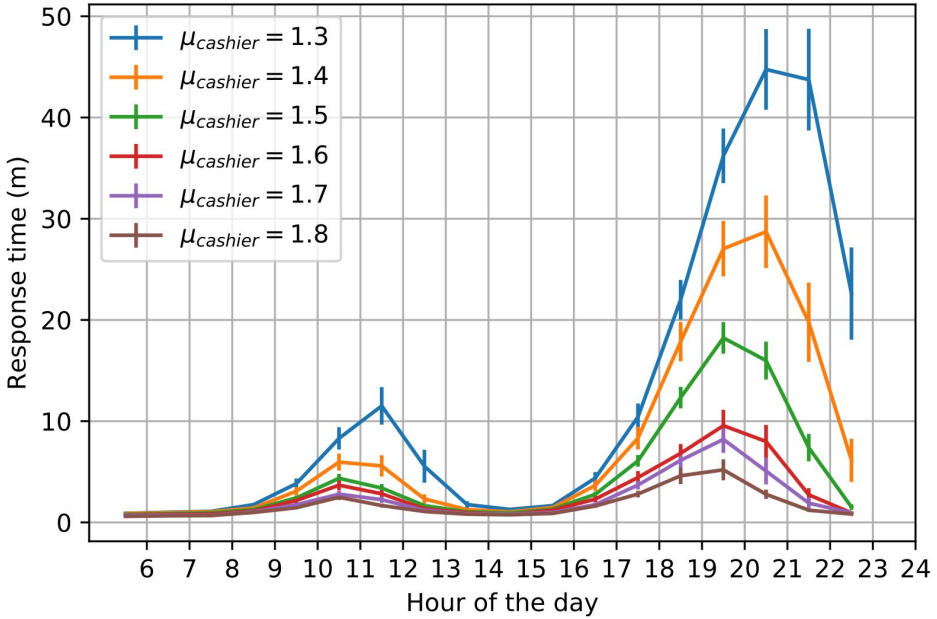




“Business day” analysis

Simulation of a **business day** with varying average arrival rates.
On the **left**, VIP and normal customers’ response time are compared (simple orders).
On the **right**, the impact of different **cashier** rates on simple normal orders are shown.





Conclusions

- The **mean queue length** at the **kitchen** is **not influenced** by the s**peed of the cashier** (in the considered exponential scenario).
- The **number of VIP customers** over the total can **negatively impact** the satisfaction of **normal** customers.
- Introduction of **priority queueing in the kitchen** is **suggested** since it increases VIP customers benefits, while increasing normal customers' waiting time by a negligible amount.
- **Small improvements** in the cashier serving speed can have **huge benefits** on the overall customer experience during **peak times**.

Thank you