Pieter Smet, Annelies Lejon, Greet Vanden Berghe
KU Leuven, Department of Computer Science, CODeS

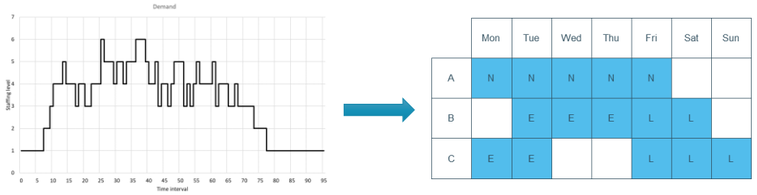
Demand smoothing in shift design

Problem setting

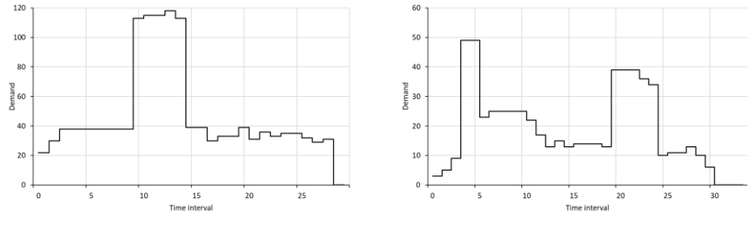
There are three main centralized decision-making processes in workforce planning:

- **Demand modelling**: task-based or time-based
- **Rostering**: days-off and shift scheduling, line-of-work construction and staff assignment, task assignment
- **Disruption handling**: re-rostering

Shift design is an essential tactical decision-making process in workforce planning in which **shift staffing levels** must be obtained to match **forecasted demand**.



Existing models for this optimization problem perform well when the demand fluctuates around an average without any strong variability in demand. When **demand is irregular**, these models inevitably generate solutions with a significant amount of **over- or understaffing** or an **excessive use of short shifts**.

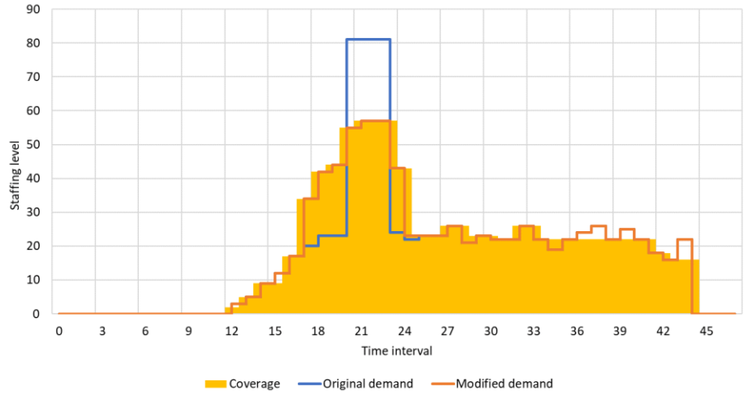


Methodology

We propose to allow for **demand smoothing** when solving the shift design problem: allowing slight adjustments to the demand patterns such that the demand may be better matched by the available shifts.

Practice imposes several restrictions on demand smoothing:

- Conservation of demand is required
- Peak demand can only be reduced, demand in adjacent intervals can only be increased
- The scope of adjustments is limited
- The amount of demand redistribution is restricted



Integer programming is used to solve this combinatorial optimization problem.

All details can be found in our journal paper:

Smet, P., Lejon, A., & Vanden Berghe, G. (2021). Demand smoothing in shift design. *Flexible Services and Manufacturing Journal*, 33(2), 457-484.

Computational study

We study **interactions between different problem parameters** which control the scope of demand modification and the type of the selected shifts.

Main conclusions:

- Increasing the permitted amount of demand redistribution is only useful when the range in which modifications are allowed is sufficiently large.
- Fewer short shifts are required when the amount of demand smoothing is increased.
- Decreases in over- and understaffing are primarily driven by the maximum number of shifts in total, and not by the maximum number of short shifts.

There is a **trade-off** between the number of months before demand smoothing becomes profitable and the cost required for modifying one unit of demand. Note that this experiment assumes a one-off modification cost to alter the demand patterns.