Container terminal management and related problems

Lecture pack No. 6B
Basics from theory of scheduling

- n jobs, m machines
- each job j has a given processing time p(j)
- each job j has a given due date d(j)
- completion time of job j = t(j)
- lateness L(j) = t(j) - d(j)
- tardiness T(j) = max(0, L(j))
In our case

- Jobs: ships awaiting service
- Machines: cranes, other equipment (straddle carriers, trucks, etc)

- Processing time: berthing, mooring, unloading, loading, unmooring, departure
Measures of performance

**MINIMIZE**
- Maximum completion time (makespan)
- Total completion time
- Average completion time
- Total lateness
- Total tardiness
- Maximum tardiness
1-machine problem

- Makespan independent of sequence

- Which sequence minimizes total completion time?
SPT-rule

- Sequence by non-decreasing order of processing times
SPT rule minimizes also

- Average completion time
- Total lateness
- Average lateness
Extension

- If each job \( j \) has also a weight \( w(j) \)

- Which sequence minimizes total weighted completion time?

- (weight can be cost in \$/time)
Modified SPT rule

- Sequence by non-decreasing order of $p(j)/w(j)$ ratios
Due dates

Sequencing by non-decreasing due dates

- Minimizes maximum lateness
- Minimizes maximum tardiness
Scheduling policies (OLP)

- FCFS
- Berthing on arrival
- Rendez-vous system
Rendez vous system

ΔΙΑΚΥΜΑΝΣΗ ΚΙΝΗΣΗΣ ΣΕΜΠΟ, ΣΕΠΤ. 1998
(αριθμός φυλακών ΓΦ/ημέρα)

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How it works

- Book 5 days to a year in advance
- Ask for specific number of gantry cranes
- Berthing on arrival if punctual
- Lose rendez vous if not
- 30% of terminal capacity allocated to system
- Both for container terminal and car terminal
Benefits

- Eliminate competitive disadvantage vis-à-vis other ports
- Normalize traffic peaks
- Avoid increased infrastructure costs to account for traffic peaks
- Better planning for port users (both to those who use it and to those who don’t)
Routing of straddle carriers
Reference


- Objective: minimize total container handling time
Double cycling

- Reference: Goodchild-Daganzo 2005
Optimal loading-unloading
References

Optimal berthing

- Assign ships to berths
- Assign cranes to ships

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Figure 2: Berth-time space