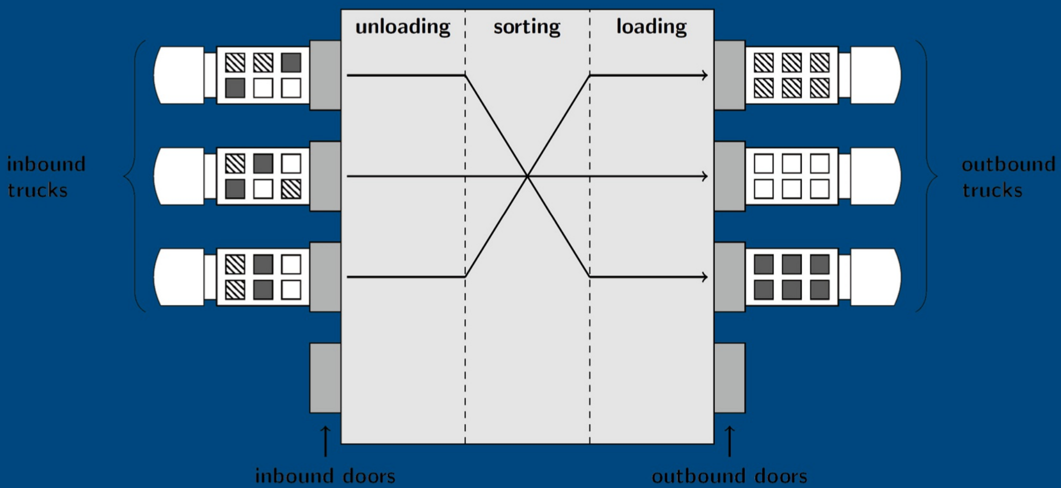
Stefan Bugow

Truck Scheduling for Parcel Hubs with Limited Conveyor Capacities



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Acknowledgements

This dissertation is the result of my work at the Institute of Production Management at Leibniz University Hannover. I would like to express my deep gratitude to all those that supported me during this time with their valuable inputs, encouragement and assistance.

Foremost, I would like to thank my supervisor Prof. Dr. Stefan Helber for his guidance, trust and insightful suggestions. He gave me the opportunity to freely pursue my research endeavours and enabled my personal and professional growth during my time at the Institute of Production Management. Further, I would like to thank Prof. Dr. Stefan Bock, head of the chair for Business Computing and Operations Research of Bergische Universität Wuppertal, for providing the second review of the thesis. I would also like to express my appreciation to Prof. Dr. Nils Foege of the Institute of Interdisciplinary Industrial Science at Leibniz University Hannover for assuming the chairmanship of the defense committee and to Dr. Michael Milde for his advisory role during the defense.

I want to express my deepest thanks to Dr. Carolin Kellenbrink who supported me as my co-supervisor. Her guidance and patient supervision helped me from the first research steps through many ups and downs and finally led to a successful joint publication in the end.

I am very thankful to Dr. Insa Südbeck and Dr. Fabian Friese for proofreading the initial version of this book and providing their input. Their critical remarks and valuable comments gave me with the opportunity to significantly improve this work.

A special thanks also goes out to all colleagues at the Institute of Production Management, who I have tremendously enjoyed working with. I will look back fondly to the animated discussions during coffee breaks, exciting visits to international conferences, joint cooking sessions and relaxing picnics in the park. Even in the tougher times throughout the pandemic they managed to keep me on track with joint sessions on the Discord voice servers and other online activities. Here, I would like to express my special appreciation for Dr. Insa Südbeck and Justine Broihan with whom I started the final phase of the research project at about the same time. I do not think that I would have been able to finish the project as smoothly without their positive encouragement and always lending a sympathetic ear when needed. Further, I would like to thank Dr. André Schnabel for being such a great office colleague during our shared time at the Institute of Production Management. My thanks also go out to my former colleagues Dr. Fabian Friese, Luise-Sophie Hoffmann, Ariane Kayser, Martin Klingebiel, Inka Nozinski, Niklas Pöch, Dr. Steffen Rickers, Dr. Cinna Seifi and Sebastian Wegel. They will always have a special place in my heart.

Finally, I am forever thankful to my family and friends for supporting me during this important period of my life. Without their kind support and backing this work would not have been possible.

Hannover Stefan Bugow
January 2023

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Acronyms

CDAP	Cross Dock Assignment Problem
FCFS	First Come First Served
FRCPSP	Resource-Constrained Project Scheduling Problem with flexible Resource Profiles
LP	Linear Program
LTT	less-than-truckload
NP	nondeterministic polynomial time
PHSP-LCC-flex	Parcel Hub Scheduling Problem with Limited Conveyor Capacities and Flexible Unloading Speeds
PHSP-LCC-fix	Parcel Hub Scheduling Problem with Limited Conveyor Capacities and Fixed Unloading Speeds
PHSP-LCC	Parcel Hub Scheduling Problem with Limited Conveyor Capacities

Symbols

α	parcel destination heterogeneity factor
at_j	arrival time of inbound j
β	gate scarcity factor
bl_o	total number of parcels in outbound o
C_{max}	schedule length
C_λ	completion time of λ
$conv_k$	current utilization of conveyor k
$\overline{d}_\lambda$	deadline of type λ
d_i	unloading duration of inbound i
di_m	length of interval m
dl_o^{max}	last deadline
dl_o	deadline of outbound truck o
dp_p	unloading duration of parcel p
$EL(t^c)$	events e in event list at time t^c
ES_u	earliest starting time at gate u
$g, u \in G$	set of inbound gates/doors
$i, j \in \mathcal{I}$	inbound trucks $\mathcal{I} = \{1, \ldots, I\}$
$i \in \mathcal{I}_t \subseteq \mathcal{I}$	inbound trucks i available in period t with $\mathcal{I}_t = \{at_i, \ldots, T\}$
$i \in J_t \subseteq \mathcal{I}$	available inbound trucks in period t
$k \in \mathcal{K}$	conveyor belts $\mathcal{K} = \{1, \ldots, K\}$
λ	parameter reference type
l_i	number of parcels in inbound truck i
lk_{ik}	number of parcels in inbound truck i designated for conveyor k
L_{max}	maximum lateness
$load_i$	current loading status of inbound i
lr_{ik}	rate of parcels in inbound truck i designated for conveyor k per period

λ^{RK}	random key representation of a solution
$m \in \mathcal{M}$	intervals $\mathcal{M} = \{1, \ldots, M\}$
$MJ_i \subseteq \mathcal{M}$	available intervals for inbound truck i
$N_t \subseteq \mathcal{M}$	active intervals at period t
μ	deadline distribution factor
$M^- \subseteq \mathcal{M}$	subset of intervals ending before the last deadline
N	population size
$o \in \mathcal{O}$	outbound trucks $\mathcal{O} = \{1, \ldots, O\}$
$o \in O_k \subseteq \mathcal{O}$	subset of outbound trucks connected by conveyor belt k
$O_i^{sub} \subseteq \mathcal{O}$	random subset of outbound trucks
oc_g	status of gate g
p	standard processing time
$PA(t^c)$	parking lot status at time t^c
pc_k	remaining share of parcels for conveyor k
p_j	processing time of inbound j
$\overline{p}$	maximum processing time
pos_i	position of inbound truck i
pu_o	remaining share parcels for outbound o
$\underline{p}$	minimum processing time
q	uniformly distributed random number from the interval $[0, 1]$
r_k	capacity of conveyor k
r_k^{LB}	lower bound for the conveyor capacity
rt_{kt}	current utilization of conveyor k in period t
$s \in S$	shipments
σ	conveyor scarcity factor
seq	decoded truck sequence from random key representation of a solution
seq^l	parcel unloading sequence
$ship_{io}$	parcels for outbound truck o in inbound truck i
S_{max}	maximum inventory
S_λ	stored quantities of λ
$start_i^*$	optimized starting time for inbound i
st_m	starting period of interval m
$ST(t^c)$	system state at time t^c
$t, \tau \in \mathcal{T}$	periods $\mathcal{T} = \{1, \ldots, T\}$
$t \in T_i \subseteq \mathcal{T}$	periods available for inbound truck i with $\mathcal{T}_i = \{at_i, \ldots, T\}$

$\bar{t}$	time limit
t^c	current time
t^e	time of event e
t_{io}	transfer time from inbound i to outbound o
T_λ	tardiness of λ
T^{norm}	standard planning horizon length
U	number of inbound doors
U^{LB}	lower bound for the number of gates
u'	gate with the earliest starting time
uf_{ito}	number of duly parcels for outbound truck o if inbound truck i is scheduled at period t
U_λ	number of tardy outbound trucks $\lambda = o$ or shipments $\lambda = s$
um_{mo}	percentage of duly parcels for outbound truck o if an inbound truck is scheduled in interval m
w_λ	value/weight of λ
wl_{kt}	workload on conveyor k at period t
$x_{it} \geq 0$	number of parcels unloaded in period t from inbound truck i
$x_{it}^{re} \geq 0$	number of parcels unloaded in period t from inbound truck i in reduced LP
x_{it}^{share}	share of parcels unloaded in period t from inbound truck i
x_{it}^{up}	maximum number of parcels unloaded in period t from inbound truck i in fixed schedule
x_i^{min}	minimum number of parcels unloaded each period from inbound truck i
x_i^{max}	maximum number of unloaded parcels each time period from inbound truck i
y_{it}	$= \begin{cases} 1, & \text{if inbound truck } i \text{ is scheduled in period } t \\ 0, & \text{otherwise} \end{cases}$
z_i^{start}	starting time of inbound i
z_i^{end}	ending time of inbound i
z_{im}	$= \begin{cases} 1, & \text{if inbound truck } i \text{ is assigned to interval } m \\ 0, & \text{otherwise} \end{cases}$

z_{it} $= \begin{cases} 1, & \text{if inbound truck } i \text{ is at a door in period } t \\ 0, & \text{otherwise} \end{cases}$

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