Synchromodal transport re-planning using Agent-Based Modelling

Shafagh Alaei*, Javier Durán-Micco, Cathy Macharis

IPIC 2023
9th International Physical Internet Conference
June 13-15, 2023
Athens, Greece

Introduction

!"#$%&' (')*+ ,&*#-.'&/ 0!,1 2- *# 34'+5/2'# '6 (5+/2(')*+ /&*#-.'&/7 8%3&3 2#4'+43- /%3 **flexible** .+*##2#9 '6 /&*#-.'&/ .&'$3--3- *#) /%3 *:2+2/" /' -82/$% 2# **real-time** :3/833# (')3- '6 /&*#-.'&/ :*-3) '# /%3 /%3 *4*2+*:+3 &3-'5&$3-72(.'-2#9 $'(.+3;2/" /' /%3 .+*##2#9 .&'$3--< =/ '663&-**integrated**7 **optimal**7 *#) **sustainable** +'92-/2$- -'+5/2'#<

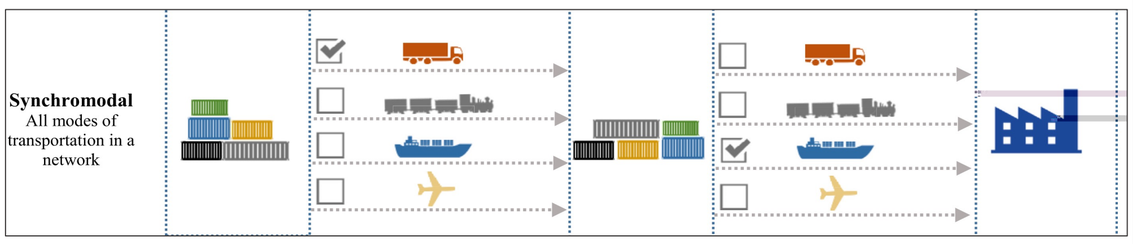
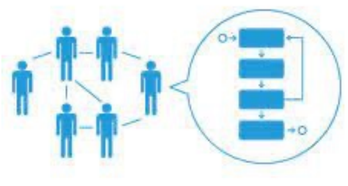


Fig1: A representation of ST [1]

Methodology

Agent-Based Simulation



> ,'?-/5)"?(5+/2.+3? *$/'&-@?:3%*42'5&A
> ,%32&?2#/3&$'##3$/242/"? *#)?2#/3&*$/2'#-<

ScopeB?C392'#*+>+343+?#3/8'&DA
Decision horizonB?!%'&/>/3&(A
PrespectiveB?E'92-2/$-?-3&42$3?.&'42)3&-@?0E!F-@1A
Logistics operationsB?G3#/&*+2H3)?*#)?)3$3#/&*+2H3)A
GoalB?/''?/&*#-.'&/?'&)3&-?/''?/%32&?)3-/2#*/2'#-?82/%2#?/%3? /2(3?82#)'87?8%2+3?(2#2(2H2#9?/%3?$'-/-?*#)?3((2--2'#-<

Simulation model

,%3 (')3+ &3.&3-3#/- /%3 '.3&*/2'# '6 -343&*+ E!F-7 2#/3&*$/2#9 /' (33/ /%3 /&*#-.'&/ &3I53-/-< ,%3 (')3+ 2- * $'(:2#*/2'# '6 -%'&/ *#) +'#9> %*5+ /&*#-.'&/< C'*)-7 &*2+-7 *#) =J J *&3 /%3 *4*2+*:+3 (')3-< ,&5$D- *&3 6+3;2:+37 :5/ /&*2#- *#) :*&93- 6'++'8 62;3) -$%3)5+3-< K&)3&- *&&243 **stochastically** 2# /%3 -"-/3(< ,%3?**objective function** 2-B

➔/''?(2#2(2H3?/%3?$'-/-?0)3+*"-7?/&*#-.'&/7?/&*#-%2.(3#/1A
➔/'(2#2(2H3?/%3?$+2(*/3?$%*#93?2(.*$/?0GK$_2$ 3((2--2'#-?$'-/1<
L# 3;.3&2(3#/ 2- $'#)5$/3) 2# /%3 M3#3+5; 0M3+925(7 N3/%3&+*#)-7 E5;3(:5&91 &392'# 0O29P1<
,%3 (')3+ $'#-2)3&- **disruptions** 2# /%3 #3/8'&D7 8%2$% &3-5+/-2# (')262$*/2'#- 2# /%3 /&*43+ .+*#- *$$'&)2#9 /' /%3 **LSPs strategies toward the disruptions:**

0Q1 G'#43#/2'#*+ &'5/2#9 0**business as usual scenario**1A
0P1 O+3;2:+3 &3>&'5/2#9 0**synchromodal scenario**1<

Three types of relations/collaborations :3/833# E!F- *&3 *+-'-/5)23)B **competitive**7 **collaborative**7 **centralized.**

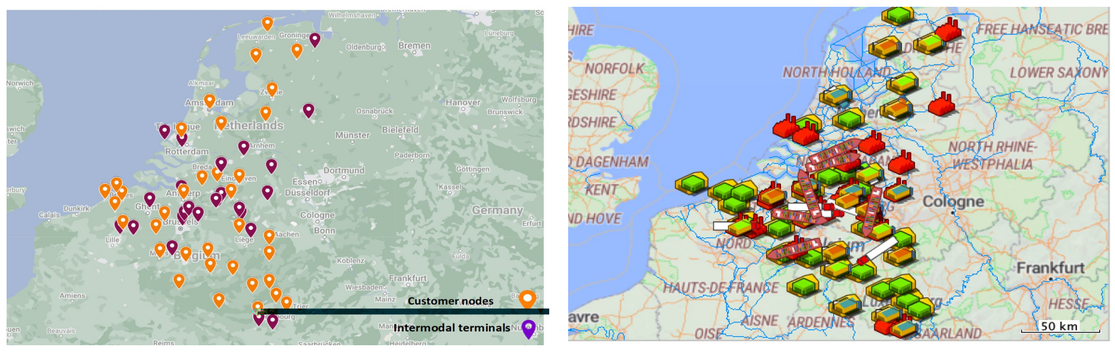


Fig2: geographic scope of the experiment

Experimental results

➔R5+/2.+3 &3.+2$*/2'#- $'#)5$/3) **to reduce the impact of stochasticty** 02#)3(*#) *#))2-&5./2'#-1A
➔N5(:3& '6 &3.+2$*/2'#-)3$2)3) :" /%3 -'6/8*&3 0L#"+'92$1 :*-3) '# #'&(*+)2-&2:5/2'# *#) */ STU $'#62)3#$3> +343+ 0'6 /'/*+ $'-/3;.&3--2'#1A
➔L#"+'92$ -/''..3) *6/3& V &3.+2$*/2'#-<

	Bussiness-as-usual	Synchromodal	
Total cost (€)	1.299.307	1.102.783	-15%
Monetary costs (€)	1.478.731	1.221.333	-17%
Emission cost (€)	880.651	826.164	- 6%
Orders transported multimodal (%)	34	44	+29%
Late deliveries	24	9	-62%
Capcaity utilization (%)	20	36	+80%

Promising outcomes

- !,?.+*##2#9?2-?('&3?**cost and environmentally efficient** /%*#?$'#43#/2'#*+?.+*##2#9?(3/%')-A
- !,?2#$&3*-3-?**flexibility** *#)?**reliability** '6?/%3?-"-/3(7?*-?/%3?.&':*:2+2/"?'6?**delivering orders on time** 2-?$'#-2)3&*:+"?%29%3&? /%*#?:5-2#3--?*-?5-5*+?-$3#*&2'-A
- =#?-"#$%&'(')*+?/&*#-.'&/7?/%3?+343+?'6?**capacity utilization** 2-?9&3*/3&<
- L?**centralized approach**7?"23+)-?2#?-343&*+?*)4*#/*93-A?2#$&3*-3)?3662$23#$"7?$*.*$2/"?5/2+2H*/2'#7?*-?83++?*-?$'-/?&3)5$/2'#<?

Reference:

[1] Farahani, N. Z., Noble, J. S., Klein, C. M., & Enayati, M. (2018). A decision support tool for energy efficient synchromodal supply chains. *Journal of Cleaner Production*, *186*, 682-702.

IPIC 2023
9th International Physical Internet Conference
June 13-15, 2023
Athens, Greece