RAPPORT

Delrapportering verktyg/statistik

Samverkan kring hållbara godstransporter

TRAFIKVERKET

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Sammanfattning

Denna rapport beskriver resultatet av en kartläggning av tillgången till verktyg/modeller och statistik/data som stöd i arbetet med genomförande av åtgärder inom *tänk om* och *optimera* inom godstransportområdet. Kartläggningen omfattar det geografiska området Norge, Sverige, Danmark och Finland.

Syftet med kartläggningen är att stödja ett nordiskt projekt med kunskapsunderlag för att föreslå och analysera affärsmodeller (organisations-/samverkansmodeller/datadelning) mellan nordiska aktörer som stimulerar till höjd fyllnadsgrad och ökad grad av användning av alla trafikslagen i gränsöverskridande godstransporter mellan de nordiska länderna. Målsättningen är ökat samutnyttjande av trafikslagen, ökad transporteffektivitet och ökad konkurrenskraft för näringslivet i Norden.

Följande modeller har bedömts intressanta utgående från tillgång för användare, tillgång till officiell data och statistik, aktualitet samt bra dokumentation.

- Samgods (Sverige)
- Nasjonal Godstransport Modell NGM (Norge)
- Den Gröna Mobilitetsmodellen GMM (Danmark)

De tre modellerna har nationella strukturer och har principiellt liknande uppbyggnad och struktur. Modellerna baseras på kostnadsminimering av logistikkedjor, transportflöden för gods och lastbärare mellan givna start och målpunkter, noder för omlastning samt kostnader. Finland har en pågående modellutveckling och framtagning av motsvarande modell som de övriga nordiska länderna och modellen planeras för analyser från år 2025/2026.

Förutsättningar för att genomföra gemensamma analyser med stöd av godsmodellerna bedöms vara god vid analyser av investeringsåtgärder i infrastruktur – justeringar och anpassningar är dock en förutsättning vid gränsöverskridande analyser. För *tänk om och optimera* liknande åtgärdsförslag kommer expertstöd och specialstudier att fortsättningsvis vara en förutsättning givet att ingen utveckling av gemensam gränsöverskridande godsmodell görs. Ingen sådan planering finns för att utöka respektive nationell modell till en nordisk modell.

Notera dock att modellerna till viss del kan tillämpas på andra åtgärdsförslag än investeringar av infrastruktur, men att modellerna i grunden är anpassade för främst investeringsåtgärder.

Nationella data och statistik finns att tillgå från ett flertal datakällor såsom handelsstatistik, rapportering till EU, varuflödesundersökningar, registeruttag från järnvägstrafik, vägmätning av lastbilstrafiken. För att utbyta data och statistik mellan datakällor inom ett land och mellan länder, på ett effektivt sätt är mycket vunnet om man har en gemensam grund och standardisering av begrepp och företeelser. Bristen på gränsöverskridande statistik är gemensam för samtliga länder. Mycket vore vunnet med ett utökat samarbete inom statistik området.

Summary

This report describes the results of the access to tools/models and statistics/data as support in the work with the implementation in rethinking and optimizing of measures in the area of freight transport. The results covers the geographical area of Norway, Sweden, Denmark and Finland.

The purpose is to support a Nordic project with a knowledge base to propose and analyse business models (organisational/collaboration models/data sharing) between Nordic actors that stimulate a high degree of occupancy and an increased degree of use of all modes of transport in cross-border freight transport between the Nordic countries. The goal is increased intermodal transport, transport efficiency and competitiveness for business in the Nordics.

The following models are interesting based on access for users, access to official data and statistics, timeliness and good documentation.

- Samgods (Sverige)
- Nasjonal Godstransport Modell NGM (Norge)
- Den Gröna Mobilitetsmodellen GMM (Danmark)

The three models have national structures and a fundamentally similar structure. The models are based on cost minimization of logistics chains, transport flows for goods, cargo carriers between given start, and destination points, nodes for transhipment and costs. Finland has an ongoing model development and creation of a corresponding model like the other Nordic countries, and the model is planned for analyses from the year 2025/2026.

Conditions for carrying out joint analyses with the support of the goods models are estimated well for analyses of investment measures in infrastructure - adjustments and adaptations are, however, a condition for cross-border analyses. For rethinking and optimizing similar measurements, expert support and special studies will continue to be a condition, given that no development of a common cross-border goods model is developed. There is no such planning to expand the respective national model into a Nordic model.

Note, however, that the models to some extent can be applied to measures other than infrastructure investments, but that the models are adapted for primarily investment measures.

National data and statistics are available from a number of data sources such as trade statistics, information to the EU, goods flow surveys, register extraction from rail traffic and road measurement of truck traffic. To exchange data and statistics between data sources within a country and between countries, in an efficient way, much is gained if you have a common basis and standardization of concepts and phenomena.The lack of cross-border statistics is common to all countries. Much would be gained with an expanded cooperation in the field of statistics.

Inledning

Denna rapport beskriver resultatet av deluppdrag verktyg och statistik. Deluppdragets uppgift är att kartlägga tillgången till verktyg/modeller och statistik/data som stöd i arbetet med genomförande av åtgärder inom *tänk om* och *optimera* (steg 1 & 2 enligt fyrstegsprincipen) inom godstransportområdet. Deluppdraget startade i mars 2022 och slutredovisas 30 november 2022.

Deluppdraget är en del i uppdrag Samverkan för hållbara godstransporter från Nordiska ministerrådet (miljöministrarna i Sverige, Norge, Danmark och Finland), men är gemensamt initierat av Sveriges Infrastruktur- och Miljödepartementet.

Bakgrund uppdraget från Nordiska ministerrådet

Projektet Samverkan för hållbara godstransporter initierades i juni 2020 och hösten 2021 tecknades ett avtal mellan Nordiska ministerrådet och Trafikverket rörande genomförande.

Projektet löper från hösten 2021 till halvårsskiftet 2025. Budget för projektet är totalt 7 MDKK (ca 10 MSEK). I projektet deltar Sverige (ansvarig för genomförande), Norge, Danmark och Finland. En styrgrupp bestående av representanter från de fyra länderna är etablerad.

Sammanfattning från projektbeskrivning

Effektiviteten i godstransportsystemet behöver öka och alla trafikslagen användas bättre för att hela transportsystemet ska kunna användas hållbart och de negativa externa effekterna från transportsektorn ska kunna minska.

Syftet med projektet är att föreslå och analysera affärsmodeller (organisations-/samverkansmodeller/datadelning) mellan nordiska aktörer som stimulerar till höjd fyllnadsgrad och ökad grad av användning av alla trafikslagen i gränsöverskridande godstransporter mellan de nordiska länderna. Målsättningen är ökat samutnyttjande av trafikslagen, ökad transporteffektivitet och ökad konkurrenskraft för näringslivet i Norden.

Det överordnade problemet som behöver lösas är att skapa affärsmässiga förutsättningar för näringslivet att utveckla flödeseffektiva upplägg med hög fyllnadsgrad där mer än ett trafikslag används och som bidrar till politisk måluppfyllelse. Fokus är på transportflöden genom flera nordiska länder. Genom bl. a. demonstration i form av horisontella samarbeten mellan nordiska varuägare och/eller transportörer. Avstämning med styrgrupp sker löpande.

Projektet delas in i

(1) Inledande analyser (Incitament/hinder, statistikanalys)

(2) Förberedande arbete Demonstratorer (bruttolista)

(3) Genomförande av Demonstratorer och tillhörandeanalys

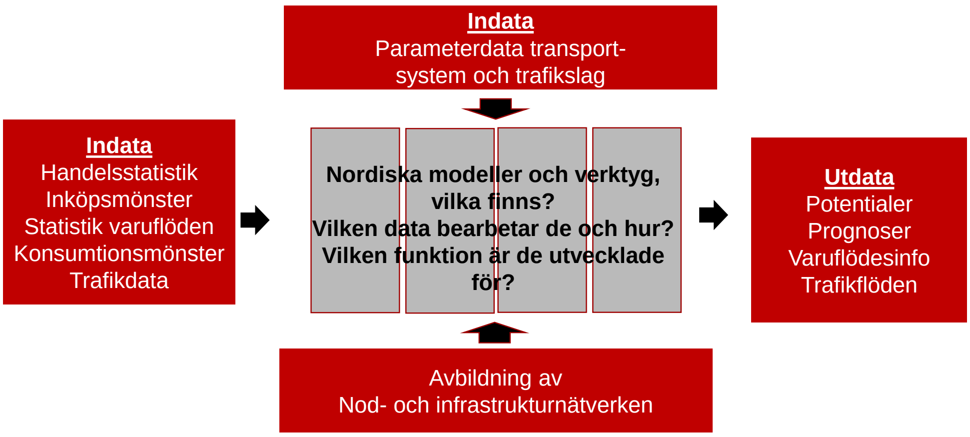
Deluppdrag verktyg och statistik

Genomförande

Trafikverket har tagit fram denna sammanfattande rapport och representanter från de nordiska länderna har bidragit som referensgrupp. Uppdraget har genomförts av en projektgrupp i Trafikverket tillsammans med konsultföretaget Ramboll. Som underlagsrapport har Ramboll tagit fram ”*Analyzing transport efficiency in Nordic cross-border freight transport – models, tools and statistics*”. I underlagsrapporten finns utförligare beskrivningar av verktyg och modeller, statistik och data samt möjligheter till att analysera *tänk om och optimera* åtgärder. Se bilaga 1 för underlagsrapporten.

Mål och syfte

Syftet med deluppdraget verktyg och statistik är att ta fram ett kunskapsunderlag som beskriver tillgång till verktyg/modeller och statistik/data som underlag och stöd för att identifiera tänk nytt och optimera åtgärder som bidrar till ökad transporteffektivitet och intermodalitet för godstransporter. Den kunskap som i första hand efterfrågas är transportflöden och dess trafikflöden för gränsöverskridande godstransporter inom respektive till och från Norden.



Figur 1, Beskrivning av in- och utdata i modeller samt frågeställningar kopplat till modeller.

Frågeställningar

- Vilka befintliga verktyg och modeller som är offentligt tillgängliga kan vara relevanta för syftet? Hur kan dessa verktyg och modeller användas för att analysera tänk nytt och optimerings åtgärder?

- Skiljer sig verktyg och modeller åt mellan de olika nordiska länderna?
- Vilken typ av data/statistik finns offentligt tillgänglig som underlag i verktyg/modeller eller fristående som underlag för att identifiera eller analysera *tänk om och optimerings* åtgärder?
- Vilka brister finns i befintliga verktyg/modeller och data/statistik för att identifiera de åtgärder projektet syftar till?
- Vilka *tänk om och optimera* åtgärder kan beskrivas eller analysers med befintliga verktyg/modeller?

Tänk om och optimera

I beskrivningen av exempel på åtgärder har inspirerats av arbetet med fyrstegsprincipen som tillämpas i Sverige. Åtgärderna är sådana som kan bli aktuella i de demonstratorer projektet har i uppgift att genomföra. Syftet med demonstratorer är att visa på och bidra till transporteffektivisering och ökad konkurrenskraft i näringslivet.

Figur 2, Fyrstegsprincipen

Exempel på åtgärder hos varuägare, speditörer och transportörer:

- Strategisk/taktisk logistik/transportplanering (produktion kontra transporteffektivitet, beställningssystem, kunskap om alternativen).
  - Leveranskrav (pris, tid och kvalitet)/servicegrad av leveransen.
  - Tjänst/produktbyten (t ex träindustrin byter timmer med varandra).
- Operativ logistik- och transportplanering (effektivt genomförande).
- Konsolidering av gods/ samlastning.
- Multimodal – effektivt och konkurrenskraftigt användande av trafikslagen (väg, järnväg, sjöfart och luftfart).

- – Multimodal konsolidering av gods – vertikal och horisontell samverkan[1] (volymdrivande).
- – Organisation – Vertikal samverkan/koordinerade tjänster.
- – Noder – lokalisering, integrerad funktion, utformning tjänster och teknik på terminaler och hamnar.
- – Standardisering - administration och planeringssystem, teknik och fysisk utformning.
- – Teknikutveckling och implementering för ökad transporteffektivitet.
- – Elektrifiering av last mile för ökad klimatnytta.
- – Regulativa stimulansåtgärder.

- Standardisering av teknik/resurser (lastbärare och paket).

Geografisk avgränsning

Arbetet i projektet Samverkan för hållbara godstransporter är avgränsat till de mest dominerande transportkorridorerna vilka knyter samman de nordiska länderna Danmark, Finland, Norge och Sverige med den europeiska kontinenten.

Figur 3, geografisk avgränsning.

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[1] Horisontella samarbeten innebär att två eller flera aktörer på samma nivå delar transporter t ex två varuägare. Vertikala samarbeten inom varuförsörjning innebär att parterna i en försörjningskedja optimerar logistiken från leverantör till kund.

Verktyg och modeller

En genomgång av befintliga verktyg och modeller har gjorts och därav har en bedömning av potentialen till att analysera åtgärdsförslag inom *tänk om* och *optimera* gjorts.

De olika modellerna har identifierats via litteraturgenomgång och intervjuer. De har bedömts utgående från tillgång för användare, tillgång till officiell data och statistik, aktualitet samt bra dokumentation.

- Samgods (Sverige), Länk: Samgods - Bransch (trafikverket.se)
- Nasjonal Godstransport Modell NGM (Norge), Länk: Projections for freight transport 2018-2050. - Transportøkonomisk institutt (toi.no)
- Den Gröna Mobilitetsmodellen GMM (Danmark), Länk: Grøn Mobilitetsmodel | Vejdirektoratet
- I Finland pågår utveckling av modeller enligt Trafikledsverket.

Den norska och svenska modellen utvecklades delvis som ett samarbete mellan länderna. Modellerna har vissa skillnader, exempelvis är det olika indelning av varugrupper, områdesindelningen samt fordonskategorier och lastbärare. Den norska modellen är dessutom mer fokuserad på logistikkedjor. Den danska modellen inkluderar både personresor och godstransporter där godstransporter utgör en delmodell. Den danska godsdelen är inspirerad av Norge och Sveriges modeller.

Modellerna stödjer främst analyser av investeringar i infrastruktur och är främst anpassade för aggregerade analyser på nationell nivå.

Lokala och regionala analyser för enskilda eller grupper av företag och information om mer precisa åtgärder kan stödjas på olika sätt. I samverkan mellan näringslivets olika aktörer (varuägare, transportförmedlare, transportörer och affärssystemsutvecklare) och offentliga aktörer såsom infrastrukturutvecklare samt akademin kan nya effektivare transportupplägg utvecklas (*tänk om* och *optimera* åtgärder).

Även om modellerna i de nordiska länderna konceptuellt är likartade skiljer de sig åt i detaljer och funktioner. På grund av skillnaderna skulle det vara en omfattande uppgift, tid och kostnader, att slå ihop modellerna.

Statistik och data

I den inventering av statistik/data som uppdraget genomfört har olika typer av statistik identifierats som intressant utifrån uppdragets frågeställning.

Handelsstatistik

Handelsstatistiken i de nordiska länderna ger en bra beskrivning av hur handeln med gods sker mellan de nordiska länderna dels i vikt (ton) och dels i monetära värden (EUR).Information om regionala handelsflöden inom och mellan de nordiska länderna saknas till stor del. De fångas bara till viss del upp av de nationella myndigheterna som ansvarar för statistik. Sverige är ensam om att genomföra återkommande undersökning av hur transporter av gods (värde och vikt) sker inom det egna landet, dock saknas insamling av uppgifter mellan eller genom länderna. Undersökningen är dels registerbaserad och dels genom enkätundersökning och har successivt förlorat i kvalitet samtidigt som det har medfört högre kostnader både för genomförandet av undersökningen och även för de företag som anmodas svara. Handelsstatistiken är trots internationella definitioner inte alltid i överensstämmelse vid jämförelse mellan hur länderna rapporterar uppgifter. Som exempel överensstämmer statistik basad på vikt inte med statistik baserad på varuvärde och i en del fall är diskrepansen allt för stor för att kunna förklaras utan ingående granskning. Eurostat är en samlande organisation för handelsstatistiken.

The Standard International Trade Classification (SITC) är framtagen av FN för att på ett standardiserat sätt klassificera gods för import och export. SITC är det enda klassificeringssystemet som är gemensamt för de nordiska länderna. Handelsstatistiken uttryckt i både värde och vikt redovisas månadsvis enligt SITC.Ansvariga för rapportering är i Norge, Sverige och Danmark de nationella statistikbyråerna och för Finland är det tullen.

Tabell 1 visar hur data kan skilja sig åt t ex i handelsrelationen Finland – Sverige, där Statistiska Centralbyrån (SCB) i Sverige redovisar 8,6 miljoner ton medan tullen i Finland redovisar 5,7 miljoner ton.

Tabell 1 Handel mellan länderna vikt (miljoner ton)

Handelsrelation	scb.se*	tulli.fi*	ssb.no*	statbank.dk*
Från SE till FI	7,8	7,8		
Från FI till SE	8,6	5,7		
Från SE till DK	6,3			7,2
Från DK till SE	6,0			5,2
Från SE till NO	8,1		7,1	
Från NO till SE	23,5		19,8	
Från FI till NO		0,9	0,9	
Från NO till FI		2,8	2,6	
Från FI till DK		0,9		1,0
Från DK till FI		0,6		0,6
Från NO till DK			8,9	8,1
Från DK till NO			2,0	2,1

*Statistik källa

Tabell 2 visar hur redovisning av handel i värde (SEK) skiljer sig åt och då i ännu högre grad än för ton. T ex handel mellan Sverige och Danmark redovisar Svenska SCB 122 miljarder SEK och Danska statsbank 285,8 miljarder SEK.

Tabell 2 Handel mellan länderna värde (miljarder SEK)*

Handels relation	scb.se**	tulli.fi**	ssb.no**	statbank.dk**
Från SE till FI	111,7	91,0		

Handels relation	scb.se**	tulli.fi**	ssb.no**	statbank.dk**
Från FI till SE	67,4	76,8		
Från SE till DK	122,0			285,8
Från DK till SE	101,7			140,6
Från SE till NO	175,4		100,7	
Från NO till SE	172,0		113,6	
Från FI till NO		19,0	15,6	
Från NO till FI		18,5	18,2	
Från FI till DK		13,5		14,4
Från DK till FI		18,7		21,7
Från NO till DK			39,9	42,9
Från DK till NO			40,2	65,8

*DKR, NKR och EUR har valuta ändrats till SEK 2022-10-03
**Statistik källa

Handelsstatistiken är redovisad på en hög aggregeringsnivå i Sverige, Danmark och Finland vilket gör att data inte kan användas till den typ av analyser som efterfrågas i uppdraget. Det kan även noteras att Norge har en högre grad av detaljeringsnivå i sin handelsstatistik.

Varuflödesinformation (varuflödesundersökningar)

Varuflödesundersökningar genomförs i Sverige och Norge på regelbunden basis. I Danmark och Finland har varuflödesundersökningar inte genomförts. Undersökningarna genomförs i form av enkäter och registerdata. Över tid har svarsfrekvensen gått ned vilket påverkar kvaliteten på enkätresultaten negativt. Informationen har delvis kunnat valideras genom registerdata från aktörer som varit villiga att lämna ut viss data ur sina affärssystem.

Data från varuflödesundersökningarna används i de nordiska modellerna. Data är dock på en hög aggregeringsnivå och kan bara i mycket begränsad omfattning användas för analyser av de åtgärder uppdraget har i uppgift att analysera.

Regionala varuflödesundersökningar genomförs ibland för att användas vid specifika regionala satsningar, oftast för infrastruktur- och bostadsplanering. Dessa har genomförts som enkät eller intervjustudier, men även som registerdatainsamling från näringslivsaktörer där de varit villiga att dela data.

Varuägare, transportförmedlare och transportörer är de aktörer som innehar uppgifter om godstransporter, de bedömer oftast att uppgifterna är en del av företagshemlighet och affärsmodeller. Vilket gör att de bara i begränsad omfattning, där data kan hanteras med sekretess, är villiga att dela data.

Vägtrafikräkningar och nationella lastbilsundersökningar

Registrering av trafiken på vägnätet är i samtliga länder av god kvalitet och sker återkommande med dels fasta mätningar året runt samt dels tillfälliga mätningar under kortare tidsperioder. Uppgifter om olika typer av fordon (tunga och lätta) registreras och kan användas vid validering av modeller och vid analyser av åtgärdsförslag. Trafikmätningar ger ingen beskrivning av transport mellan områden och saknar information om vilket gods som transporteras. Mindre avvikelser mellan länderna har observerats och relaterar framför allt till olika förhållanden vid mätningarna såsom olika typer av utrustning, osäkerhetsbedömningar och olika tidpunkter för mätning.

För tung lastbilstrafik mellan de nordiska länderna finns kartor som redovisar antal fordon per år (trafikflöden till skillnad från godsflöden, se ovan). Trafiken finns redovisad på följande sidor:

- Fordonsflöden och hastigheter - Bransch (trafikverket.se)
- Trafik på målestationer (vd.dk)
- https://paikkatieto.vaylapilvi.fi
- https://www.vegvesen.no/trafikkdata/start/kart
- Välkommen till Øresundsbron | Öresundsbron (oresundsbron.com)

I alla nordiska länder finns nationella lastbilsundersökningar genomförda, antingen som enkätundersökningar eller uttag från nationella fordonsregister.

Utländska lastbilstransporter i Sverige och Cabotagestudie i Skandinavien

Statistik om utlandsregistrerade fordon är bristfällig vilket innebär att statistiken ska användas med försiktighet. De nordiska länderna använder olika metoder vid datainsamling. Dessutom är kunskapen om olagliga cabotagetransporter bristfällig. Den kunskap som finns visar att utlandsregistrerade fordon har ökat och blivit vanligare för körningar av gods i de nordiska länderna.

Hamnstatistik

Alla nordiska länder har väl utvecklad hamnstatistik. Statistiken visar hamnens inkommande och utgående flöden i ton eller fordon och lastbärare. Statistiken skiljer något mellan länderna. Generellt ger uppgifter från hamnar angående omsättning (lassning och lossning) en god grund för att validera transportmodeller och stöd vid analyser av åtgärder som påverkar sjötransporter och hamnars funktion. En bedömning är att de svenska uppgifterna kunde utvecklas för att mer motsvara de övriga ländernas kvalitet, enskilda förfrågningar till hamn ger dock information som normalt inte publiceras.

Data för järnvägstransporter

För järnvägstransporter är tillgång till offentlig data begränsad. Uppgifter om antalet tåg och mängden trafik finns tillgängligt med bra kvalitet. Godstransporter i vikt och värde kan tas fram med hjälp av bedömningar och data som normalt kan beställas utanför det officiella redovisningssystemet. Med hjälp av expertstöd kan bedömningar göras för vissa järnvägsstråk såsom Malmbanan i Sverige (dominerande malmtransporter till Narvik och Luleå från Gällivare/Malmberget/Kiruna), Köpenhamn – Malmö/Göteborg.

Miljödata för godstransporter

The National Inventory Reports (NIR)[2] publiceras varje år och innehåller rapportering av klimatutsläpp från 1990. EU:s medlemsländer rapporterar till EU/Eurostat som därefter rapporterar till FN samlat för EU.

Miljödata kopplat till *tänk om* och *optimera* åtgärder på företagsnivå finns inte att tillgå i offentlig statistik. Företagens egen miljörapportering eller

[2] UNFCCC

data kan ligga till grund för information. Olika verktyg för beräkning av miljödata finns såsom NTM[3] och GLEC[4].

NTM modellen ger företag möjlighet att utvärdera och värdera miljömässiga och klimatrelaterade effekter för sina transporter av gods. Modellen är tillämpbar i de nordiska länderna och i övriga Europa. Modellen är ett stöd för att beräkna effekter för vilka man har en rapporteringsskyldighet inom EU (NIR).

Sammanfattning

Offentligt tillgänglig data och statistik redovisad på en övergripande och aggregerad nationell nivå. Bristen på gränsöverskridande statistik är gemensam för samtliga länder och endast enstaka undersökningar ger en kompletterande beskrivning. Definitioner är väl utvecklade för varugrupper och fordon, dock skiljer det i teknisk utrustning och olika mätperioder vilket kan bidrar till olika datauppgifter i de nordiska länderna. Godsundersökningar har ingen gemensam standard och därav kan det vara svårt att summera studier till en helhet. Kvalitetssäkrad offentlig data och statistik saknas för regional nivå vilket innebär att analyser för *tänk om* och *optimera* är svåra att genomföra för enskilda eller grupper av företag. Vilket är vad som önskas kopplat till de demonstratorer som uppdraget kommer att föreslå.

[3] www.transportmeasures.org

[4] www.smartfreightcenter.org

Brister i verktyg/modeller och data/statistik

Offentlig data och statistik redovisas på en övergripande och aggregerad nivå vilket gör det svårt att använda för analyser på specifika stråk eller för regionala och lokala åtgärder. Data och statistik skiljer sig dessutom i redovisning och insamling mellan de nordiska länderna, vilket innebär att om data och statistik ska användas så behöver analyser över skillnader göras. Stora delar av data samlas in via enkäter och kvaliteten är alltid beroende av metod och svarsfrekvens.

Vägtrafikräkningar (trafikflöden) är undantaget. Där är statistiken relevant och redovisas relativt lika för länderna. Vissa skillnader finns men dessa beror troligen på att man mäter i olika tidsperioder.

De nationella godsmodellerna i Sverige, Norge och Danmark (i Finland pågår utveckling), har god förmåga att analysera inrikestransporter, men för gränsöverskridande flöden finns tydliga begränsningar i modellerna.

De verktyg och modeller som identifierats har utvecklats för att stödja analyser av investeringsobjekt av infrastruktur. Analyser görs på systemnivå vilket innebär att i den mån det är möjligt att göra analyser av *tänk om* och *optimera* åtgärder kan detta enbart ske på systemnivå. Slutsatsen är att med dagens verktyg och modeller kan vissa *tänk om* och *optimera* åtgärder analyseras för hela transportsystemet i respektive land. De åtgärder som är möjliga att analyseras är de som styrs av prisförändringar, t. ex. styrmedel.

Lokala och regionala analyser och information om *tänk om och optimera* åtgärder, vilka kan relateras till få eller enskilda företags godstransporter och logistik, kan hanteras endast med stöd av expertgrupper med sakkunskap om godsflöden och logistik och visst modellstöd (företags datasystem samt kombination av andra modellstöd).

Tänk om och *optimera* åtgärder

I relevanta verktyg och modeller görs analyser på systemnivå vilket innebär att *enbart tänk om* och *optimera* åtgärder på systemnivå kan analyseras. För ett fåtal åtgärder (se ja/ja i **Tabell 3**) kan analyser göras för *tänk om* och *optimera* åtgärder.

Tabell 3 Varuägare

Åtgärder	Modell	Statistik
Tillgänglighet till produktionsplatser och noder	Nej	Företag
Ökad kunskap om transportmöjligheter, dialog och samarbete	Nej	Process
Planering av hela transportkedjan (ej uppdelat i enskilda delar)	Nej	Företag
Information om alla transportmöjligheter	Nej	Process
Vertikala samarbeten mellan varuägare, speditör och transportutförare	Nej	Process
Horisontella samarbeten mellan varuägare	Nej	Företag

Tabell 4 Transport och logistiktjänster

Åtgärd	Modell	Statistik
Öppna terminaler utan diskriminerande prissättning	Nej	Företag
Etableringsstöd, initiering nya transportupplägg	Nej	Nej
Nya tåglinjer vid samordning/optimering av transporter	Nej	Nej
Kvalitetshantering /planering	Nej	Företag
Långsiktig planering för att säkerställa stabilitet i intäkter och kostnader	Nej	Företag
Etableringsstöd, hyrespool fordon/vagnar	Nej	Företag
Utökade analyser av logistiksystemet	Härleda	Företag

Tabell 5 Infrastruktur optimering

Åtgärd	Modell	Statistik
Effektiva dörr till dörr transportupplägg	Härleda	Företag
Ökad tillgänglighet och service i kapacitet	Härleda	Företag
IT stödda transportupplägg med höga kvalitetskrav	Härleda	Företag
Incitament till användning av tyngre, bredare och/eller längre fordon på logistikuppläggs nivå.	Härleda	Företag
Intermodala transportupplägg med ökad kapacitet	Ja	Företag
Tidtabells optimering	Nej	Nej
Nya generationer av fordon. Kraftfullare lok, vagnar som klarar mer last	Ja	Nej
Bättre kapacitets användning	Ja	Ja
Utveckling av infrastruktur för användning av tyngre och längre fordon	Ja	Ja
ERTMS som stödjer ökad kapacitet	Ja	Ja
Vagnar med nya bromssystem (luft broms system)	Nej	Företag
Trimnings och investering i noder (hamnar och terminaler)	Härleda	Företag
Ökade tidsfönster för användning (omlastning m m) i noder	Nej	Företag

Tabell 6 policy, lagar och regler

Åtgärd	Modell	Statistik
Klimatkrav från varuägare till transportörer	Härleda	Företag
Finansiella incitament till att använda intermodala transportupplägg	Härleda	Nej
Bränsle- och andra skatter	Ja	Ja
Infrastruktur avgifter	Ja	Ja

Förbättringsförslag kopplat till verktyg och statistik

Det finns olika sätt att utveckla möjligheterna till analyser av *tänk om* och *optimera* åtgärder, några förslag är:

- Utveckla befintliga modeller med en mer avancerad struktur (stokastisk optimering).
- Utveckla stödjande av fristående modeller från dagens etablerade modeller, eller utvecklade försystem till befintliga modeller.
- Samla nödvändig data för att stödja modellerna (kan vara svårt då näringslivet är restriktiva med att dela data).

Möjligheten att analysera *tänk om* och *optimera* åtgärder beror på tillgång till transport- och trafikdata. Information om varuflöden finns idag i företagens affärssystem och ökad datadelnings skulle underlätta framtida analyser.

För flera av analyserna behövs även utvecklade effektsamband för att kunna analysera *tänk om* och *optimera* åtgärder t. ex. för fyllnadsgrad för den typ av transporter som utpekad samverkan gäller.

Förbättrad uppföljning med hjälp av fler indikatorer för transporteffektivitet och fyllnadsgrad kan bidra till möjligheter att analysera potentialer och val av effektiva åtgärder på systemnivå.

Kartläggning av samverkansprocessen för analys av *tänk om* och *optimera* åtgärder kan bidra till förbättrad kunskap om behov av verktyg och modeller, data och statistik samt kompetensbehov för deltagare i processen.

Slutsatser verktyg och statistik

De nordiska länderna har nationella modeller vilka har principiellt liknande uppbyggnad och struktur. Modellerna baseras på kostnadsminimering av logistikkedjor, transportflöden för gods och lastbärare mellan givna start och målpunkter, noder för omlastning samt priser och kostnader. Finland har en pågående modellutveckling och framtagning av motsvarande modell som de övriga nordiska länderna och modellen planeras för analyser från år 2025/2026.

Förutsättningar för att genomföra gemensamma analyser med stöd av godsmodellerna bedöms vara god vid analyser av investeringsåtgärder i infrastruktur – justeringar och anpassningar är dock en förutsättning vid gränsöverskridande analyser. För *tänk om och optimera* liknande åtgärdsförslag kommer expertstöd och specialstudier att fortsättningsvis vara en förutsättning givet att ingen utveckling av gemensam gränsöverskridande godsmodell utvecklas.

Sverige	Samgods	Nationell nivå
Norge	NTM	Nationell nivå
Danmark	LTM	Nationell nivå
Finland	Modell under utveckling (år 2025/2026)	

Notera dock att modellerna till viss del kan tillämpas på andra åtgärdsförslag än investeringar av infrastruktur, men att modellerna i grunden är anpassade för främst investeringsåtgärder.

Nationella data och statistik finns att tillgå från ett flertal datakällor såsom handelsstatistik, rapportering till EU, varuflödesundersökningar, registeruttag från järnvägstrafik, vägmätning av lastbilstrafiken. Standardisering är en grund för att utbyta data och statistik på ett effektivt sätt. Dock saknas det samordnande rutiner för ett utbyte av data mellan länderna.

Analysing transport efficiency in Nordic cross-border freight transport – models, tools and statistics

Final report
Malmö 2022–11–30

Analysing transport efficiency in Nordic cross-border freight transport – models, tools and statistics

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Summary

This report has been commissioned by The Swedish Transport Administration as part of the Nordic Council collaboration regarding sustainable freight transport. A steering group consisting of staff from The Swedish Transport Administration has been responsible for directing the work together with the consultants at Ramboll.

This study aims to investigate which models, tools and statistics exist today for carrying out quantitative analysis of measures that influence demand for transportation and optimisation of the transport system. In Sweden the four-step principle is a central part of the National Plan, comparable planning is implemented in all Nordic countries, and this report looks primarily at steps 1 (Re-think) and 2 (Optimise) and less at step 3 (Repurpose) and 4 (Build new). In this study focus has been on evaluating possibilities to analyse re-think and optimisation measures for Nordic cross-border transport.

To this end, this study has looked at what data and statistics currently exist in the Nordic region and point-out where there are likely to be issues in quality or comparison of the data. Furthermore, the report includes an inventory of potential freight transport models and assessed specifically models that fulfil the set of requirements defined.

A short assessment has then been carried out as to how these models can be used to study measures that influence demand or optimisation of cross-border transport and transport efficiency. The report highlights that there are very few examples of measures of this kind that can be adequately modelled with the tools that exist today, and most measures would need significant and complicated development work as well as huge amounts of new, and difficult to obtain, data and statistics.

More realistic would be to investigate further which and how some demand and optimisation measures can be handled in a reasonable way within the framework for the existing models and tools. This could be done taking into account all the national freight models in the Nordic countries. A combined Nordic freight model would require in itself be a major task to develop.

The assessment also shows that out of 31 identified measures only 6 can be supported with official statistics. In contrast 19 measures are dependent on companies' business processes and access to confidential data. Only five measures are possible to model and supported by available statistics.

For environmental analysis the outcome is dependent on the quality of transport statistics. In Sweden there are significant quality challenges due to lack of information on foreign registered vehicles. For all countries railway statistics is limited.

Summering

Denna rapport har gjorts på uppdrag av Trafikverket som en del av Nordiska rådets samarbete kring hållbara godstransporter. En styrgrupp bestående av personal från Trafikverket har ansvarat för att leda arbetet tillsammans med konsulterna på Ramboll.

Denna studie syftar till att undersöka vilka modeller, verktyg och statistik som finns idag för att genomföra kvantitativ analys av åtgärder som påverkar efterfrågan på transporter och optimering av transportsystem. I Sverige är fyrstegsprincipen en central del av den nationella planen, motsvarande planering är implementerad i alla nordiska länder, och denna rapport tittar i första hand på steg 1 (Tänk om) och 2 (Optimera) och mindre på steg 3 (Bygg om) och 4 (Bygg nytt). I den här studien har fokus legat på att utvärdera möjligheter att analysera tänk-om och optimeringsåtgärder för nordiska gränsöverskridande transporter.

För detta ändamål har denna studie tittat på vilken data och statistik som för närvarande finns i Norden och peka ut var det sannolikt finns problem med kvaliteten eller jämförelsen av data. Vidare innehåller rapporten en inventering av potentiella godstransportmodeller och bedömda specifikt modeller som uppfyller de definierade kraven.

En kort bedömning har sedan gjorts av hur dessa modeller kan användas för att studera åtgärder som påverkar efterfrågan eller optimering av gränsöverskridande transporter och transporteffektivitet. Rapporten lyfter fram att det finns mycket få exempel på åtgärder av det här slaget som kan modelleras på ett adekvat sätt med de verktyg som finns idag, och de flesta åtgärder skulle kräva ett betydande och komplicerat utvecklingsarbete samt enorma mängder ny, och svårtillgänglig, data och statistik.

Mer realistiskt vore att undersöka ytterligare vilka och hur vissa efterfråge- och optimeringsåtgärder kan hanteras på ett rimligt sätt inom ramen för de befintliga modellerna och verktygen. Detta skulle kunna göras med hänsyn till alla nationella fraktmodeller i de nordiska länderna. En kombinerad nordisk fraktmodell skulle i sig kräva en stor uppgift att utveckla.

Bedömningen visar också att av 31 identifierade åtgärder endast 6 kan stödjas med officiell statistik. Däremot är 19 åtgärder beroende av företags affärsprocesser och tillgång till konfidentiella data. Enbart fem åtgärder kan både modelleras och understödjs av offentligt tillgänglig statistik.

För miljöanalys är utfallet beroende av kvaliteten på transportstatistiken. I Sverige finns betydande kvalitetsutmaningar på grund av bristande information om utlandsregistrerade fordon. För alla länder är järnvägsstatistiken begränsad.

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1. Background

1.1 The Goal and Purpose of Cooperation for Sustainable Transport

The project Cooperation for Sustainable Transport (Projektet Samverkan för hållbara transporter) is on behalf of the Nordic Council of Ministers and the overarching goal with the project increase competitiveness and sustainability for industry and society's freight transport between the Nordic countries.

The purpose of the project is to propose re-thinking and optimisation measures according to the Four-step Principle[1] which contributes to improved transport efficiency, increased transport loads and higher proportion of intermodal use for cross-border freight transport between the Nordic countries. The measures should not simply be described in terms of functionality but also as business models. The ambition is that the measures can be established on the Nordic market and continue in the long-term.

The objective is to produce knowledge and information regarding the conditions for re-thinking and optimising measures. The documents will describe opportunities for increased transport efficiency, intermodal solutions, and competitiveness. This will provide the basis to demonstrate measures in collaboration with the business sector.

1.2 Purpose of the sub-project tools and statistics

The purpose of the sub-project "Tools and statistics" is to produce a knowledge base that describes access to publicly available tools/models and statistics/data as a basis and support for identifying re-thinking and optimizing measures that contribute to increased transport efficiency and intermodal solutions. The knowledge that is primarily desired is goods flows and associated traffic flows for cross-border freight transport within and to and from the Nordic Region.

The purpose of the study is to briefly describe what publicly available data/statistics and tools/models exist.

[1] trafikverket.diva-portal.org/smash/get/diva2:1364091/FULLTEXT01.pdf

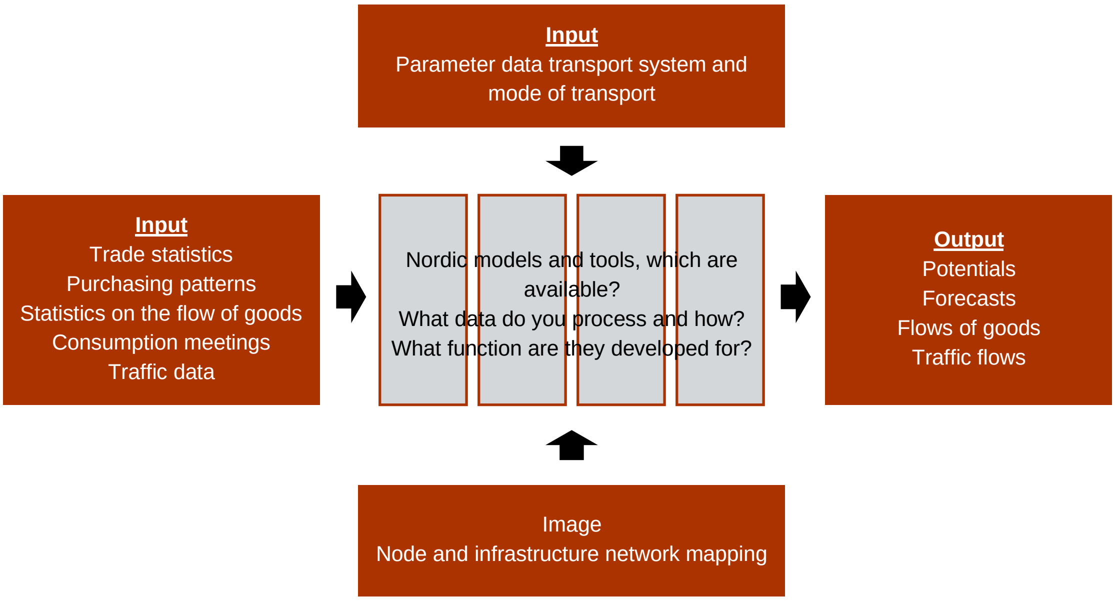

Figure 1 General overview of the sub-project (Swedish)

The information should contain:

- Inventory of existing tools and models that are publicly available.
- How can these tools and models be used to analyse demand and optimisation measures that can affect increased transport efficiency and intermodal solutions?
- Do tools and models differ between the various Nordic countries?
- What shortcomings are there in the existing tools/models (input data, data analyses, algorithms, etc.) for the purpose of identifying the measures the project aims at?
- Which re-think and optimisation actions cannot be described or analysed with existing tools/models?
- Compilation of the type of data/statistics that are publicly available for the tools/models or stand-alone for identifying demand and optimisation measures according to re-thinking and optimisation.
- What shortcomings are there in the available data/statistics to identify the measures the project aims at?
- Description of future functionality of tools/models and data/statistics for demand and optimisation measures.

The process can be defined in the following three steps:

1. What statistics and data are available?
2. How far can we come with existing tools/models?
3. What functionality is needed for future tools/models to carry out Nordic cross border studies?

1.3 Cross-border transport

Traffic volumes between the Nordic countries are found on the Öresund bridge, at the road border crossings east of Oslo, at Haparanda-Torneå and on the ferry lines that carry both trailers and lorries, but no rail freight wagons. The ferry connections are:

- Stockholm – Turku/Helsinki,
- Hirtshals - Oslo/Larvik/Kristiansand
- Gothenburg-Fredrikshamn
- Helsingborg – Helsingör

Figure 2 Border crossing between Nordic countries (European road network, railway and ferry).

Railway cross-border transport are primarily found at Riksgränsen (mainly iron ore transport between Swedish mines and the port of Narvik), and on the Öresund bridge (both wagonload and intermodal trains).

This work package focuses on descriptive analysis of Nordic freight models and available statistics for the purpose of analysing changes in demand and optimisation measures. This work package does not analyse forecast methodology. Air freight transport is not included in the analysis, due to limited volumes.

2. Re-think and optimisation measures

The four-step principle in Sweden has been developed by The National Transport Administration in order to widen the toolbox for planners and to find the most cost-effective measures for infrastructure planning. Comparable planning is implemented in all Nordic countries. The principle requires that four different kinds of measures are analysed when addressing transport issues:

1. Measures that affect transport demand and choice of transport mode.
2. Measures leading to more efficient utilisation of existing infrastructure.
3. Minor infrastructure improvements.
4. Major infrastructure investments

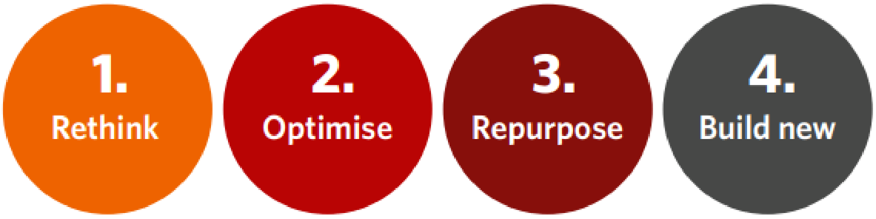

Figure 3 The Swedish 4-step principle for National Planning

This study has identified several organisational and system measures to promote transport efficiency and intermodal solutions. These measures are to a large extent dependent on private sector actors and initiatives. Among private sector actors are the goods owners, freight forwarders and transport companies. Below are examples of demand and optimisation measures that authorities could potentially be interested in analysing with the help of models and tools.

Figure 4 Categories of re-thinking and optimisation measures

Table 1 below summarizes expected effects of 31 identified measures for re-thinking and optimisation. We do not claim that all possible measures are included. The expected effects are, in a very summarized way, described as:

- **Efficiency**, that refers to measures that promote more efficient unimodal transport (road and/or railway)
- **Intermodality**, that refers to measures targeting railway measures increasing competitive power for intermodal solutions.
- **Logistic solutions**, that refers to measures that promote both the development of new, more efficient, logistic solutions and increases transport efficiency

The following table, Table 2, summarizes the possibilities to model re-thinking and optimisation measures with the analysed national models for Sweden, Denmark, and Norway. Finland does not have a national model. The column model refers to a combination of the three national models. That is, modelling can be possible with one or several of the studied models. The column statistics refers to availability of official regular statistic production with accounting and surveys, statistics/data that are available at company level or if quantitative data do not exist as regularly produced data. The options for modelling and availability of statistics are described as:

- **Yes**, the measure is possible to model and/or official statistics are available
- **No**, the measure is *not* possible to model and/or official statistics are *not* available
- **Company**, refers to data available at companies but that are not officially available
- **Derived,** refers to data derived from cost data that is possibility to make "what-if" analysis even though statistics are not available.
- **Process,** refers to knowledge, collaboration and dialogue processes within and between companies.

From Table 2 it stands clear that for many measures official statistics are to a limited extent available. Data needed for analysis and that would enable model analysis can often be found at company level. However, these data are usually considered as business secrets. Most measures that can be modelled can only be modelled at traffic system level and not for particular companies or group of companies. Measures marked in red have conditions for available data *and* model and with that potential for performing analysis.

Of the 31 measures only 6 can be supported with official statistics. In contrast 19 measures are dependent on companies' business processes and access to confidential data. Only 8 measures ca be modelled, although further 8 measures can be analysed as "what-if" by making cost assumptions. A more thorough discussion on the possibilities to analyse re-thinking and optimisation measures are found in chapter 8.

Table 1 Expected effects of re-thinking and optimisation measures

Category/Measure	Expected effects
Freight owners	
Accessibility of production and logistics locations	Efficiency
Improved knowledge, dialogue, and collaboration	Logistic solutions
Consider the entire transport chain and not only individual legs	Logistic solutions
Information and awareness	Logistic solutions
Vertical liaison between owner, freight forwarder and carrier	Logistic solutions
Transport and logistical services	
Commercially open terminals with non-discriminatory pricing	Intermodality
Financial subsidy at start-up	Logistic solutions
Re-thinking of train routes for coordinated timetables	Intermodality
Quality management	Efficiency
Horizontal collaboration between goods owners to share information	Logistic solutions
Long-term planning to ensure stability in revenue and costs	Logistic solutions
Establishment aid (not subsidy), Rent-pool intermodal carriers,	Logistic solutions
Extension of analytics to the logistics system	Efficiency
Infrastructure optimisation	
New efficient and competitive door-to-door transport systems	Efficiency
New transport system with new production system with increased availability and service level	Logistic solutions
Transport system for goods with high quality requirements supported by IT systems	Efficiency
Incentives to use longer, heavier and/or wider carriers and vehicles to and from a terminal or port	Intermodality
Integration of production systems (e.g. wagonload and intermodal => block trains), sea and rail in combination (rail to port) and/or new transport system with increased transport capacity	Logistic solutions
Coordinated working timetable/change in working timetables	Efficiency
New generation of vehicles and craft. More powerful locomotives and more high-carrying wagons and larger craft, respectively.	Intermodality
Better capacity utilisation	Efficiency
Upgrade the infrastructure according to longer and more capable trains and craft	Intermodality
ERTMS signalling system increases the potential for increased speed	Intermodality
New wagons. Transition of air braking systems, with associated regulatory changes	Intermodality
Trimming or physical measures. Functional nodes (ports and terminals) = > reduced time and costs	Efficiency
Changing restrictions. Expanded time windows for traffic to and from nodes, incl. management	Efficiency
Policy and regulations	
Infrastructural restrictions	Logistic solutions
Climate effects and choices filtered down from freight owners to transport buyers and planners	Logistic solutions
Stimulus needed to increase financial incentives to shift to rail	Logistic solutions
Fuel and other taxes	Logistic solutions
Infrastructure fees	Logistic solutions

Table 2 Options for modelling and available statistics

Category/measures	Modell	Statistics
Freight owners		
Accessibility of production and logistics locations	No	Company
Improved knowledge, dialogue, and collaboration	No	Process
Consider the entire transport chain and not only individual legs	No	Company
Information and awareness	No	Process
Vertical liaison between owner, freight forwarder and carrier	No	Process
Transport and logistical services		
Commercially open terminals with non-discriminatory pricing	No	Company
Financial subsidy at start-up	No	No
Re-thinking of train routes for coordinated timetables	No	No
Quality management	No	Company
Horizontal collaboration between goods owners to share information	No	Company
Long-term planning to ensure stability in revenue and costs	No	Company
Establishment aid (not subsidy), Rent-pool intermodal carriers,	No	Company
Extension of analytics to the logistics system	Derived	Company
Infrastructure optimisation		
New efficient and competitive door-to-door transport systems	Derived	Company
New transport system with new production system with increased availability and service	Derived	Company
Transport system for goods with high quality requirements supported by IT systems	Derived	Company
Incentives to use longer, heavier and/or wider carriers and vehicles	Yes	Company
Integration of production systems (e.g. wagonload and intermodal => block trains), sea and rail in combination (rail to port) and/or new transport system with increased transport capacity	Yes	Company
Coordinated working timetable/change in working timetables	No	No
New generation of vehicles and craft. More powerful locomotives and more high-carrying wagons/larger craft.	Yes	No
Better capacity utilisation	Yes	Yes
Upgrade the infrastructure according to longer and more capable vehicles and craft	Yes	Yes
ERTMS signalling system with the potential for increased speed	Derived	No
New wagons. Transition of air braking systems, with associated regulatory changes	No	Company
Trimming or physical measures. Functional nodes (ports and terminals) = > reduced time/costs	Derived	Company
Changing restrictions. Expanded time windows for traffic to and from nodes, and management	No	Company
Policy and regulations		
Infrastructural restrictions	Yes	Yes
Climate effects and choices filtered down from freight owners to transport buyers and planners	Derived	Yes
Stimulus needed to increase financial incentives to shift to rail	Derived	No
Fuel and other taxes	Yes	Yes
Infrastructure fees	Yes	Yes

3. Trade and commodity flow between Nordic countries

This chapter describes relevant data sources and statistics regarding Nordic trade flows with a focus on cross-border relations. The chapter starts by describing the high-level foreign trade statistics in terms of both weight and value and includes the various sources and how they differ. Following that the commodity flow surveys are described.

3.1 Foreign trade statistics in the Nordic countries

There are several statistical tables with different commodity nomenclature for international comparison. **The Standard International Trade Classification (SITC)** updated by the UN is a standardized way of classifying goods that is used in statistics on imports and exports. The commodity nomenclature is detailed with 2 975 commodity groups. SITC is the only classification of foreign trade that is easily available for all Nordic countries.

SITC contains imports and exports by country with monthly updates and are available both as monetary value and weight. The responsible authorities are the national statistical bureaus in Sweden, Norway and Denmark, while in Finland it is the Customs.

The statistics are comparable with other countries' external trade statistics, which follow the basic principles of the UN guidelines. As EU member states trade statistics in Sweden[2], Denmark[3] and Finland[4] follow common methodology for data collection.

The Norwegian foreign trade statistics is primarily based on customs register data[5]. The Norwegian customs area only covers mainland Norway and associated territorial waters. Alternative sources are used for imports or exports that fall wholly or partly outside the scope of the customs authorities. Statistics Norway collects information directly from issuers and other registers to cover trade in important goods to and from the remaining parts of the economic territory. Figures for exports of crude oil and gas delivered directly from the continental shelf are based on information from the Norwegian Petroleum Directorate and operators. Export and import of ships, aircraft and floating oil platforms are obtained from Norwegian ship registers and contractors.

EU trade statistics are divided into Intrastat and Extrastat. For trade with EU countries, Intrastat, the population is defined as enterprises which have trade of a value which exceed an exemption threshold.

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[2] SCB (2022) Kvalitetsdeklaration. Utrikeshandel med varor.
[3] https://www.dst.dk/en/Statistik/dokumentation/documentationofstatistics/international-trade-in-goods
[4] https://tulli.fi/en/statistics/information-on-statistics
[5] https://www.ssb.no/utenriksokonomi/utenrikshandel/statistikk/utenrikshandel-med-varer

In addition to the reported values, information from VAT declarations is used. Various model assumptions are made, partly for reporting companies that have not reported values, and partly for companies with trade below the reporting threshold.

Extrastat cover trade with non-EU countries and is based on toll declarations. In Extrastat, information on country of origin (country of manufacture) is collected and for imports information on country of dispatch, and for exports information on country of destination is collected. In most situations, it is information on country of origin that is applied in Extrastat.

For trade with EU countries, Intrastat, the population is defined as enterprises which have trade of a value which exceed an exemption threshold.

In addition to the reported values, information from VAT declarations is used. Various model assumptions are made, partly for reporting companies that have not reported values, and partly for companies with trade below the reporting threshold.

External trade can be compiled according to two different principles: the general trade system and the special trade system.

- General trade comprises all goods being moved into or out of the country unless exceptions have been laid down in special rules. Thus, imports cover all goods entering the country, including goods intended for re-export or goods that are, in fact, re-exported. Similarly, exports cover all goods leaving the country, whether processed in the country or have previously been imported (re-export).
- The special trade system excludes transactions between other countries and member state customs bonded warehouses. Goods imported to a bonded warehouse are thus excluded from external trade based on the special trade principle and are only included when the goods are declared by the customs to the member state.

Furthermore, the value of external trade can be estimated by a so-called statistic value or payment value.

Trade flows between Sweden and its neighbouring Nordic countries can serve as an example of differences in the statistics for the same trade flow according to easily available tables from each country.

Trade, measured in weight, from Finland to Sweden differ considerably as Finnish statistics account for 5,7 million tonnes, while Swedish statistics account for 8,6 million tonnes. For other trade relations the volume in tonnes is in a similar order of magnitude (see Table 3).

Measured in value, the national statistics differ considerably (see Table 4). The trade value from Sweden to Denmark accounts for 122,0 billion SEK in Swedish statistics, but 285,8 billion SEK according to Danish statistics. In the opposite direction from Denmark to Sweden the Swedish statistics account for 101,7 billion SEK while Danish statistics account for 140,6 billion SEK.

Other trade relations (value) with significant differences between the statistic bureaus are between Sweden and Norway (both directions) and from Denmark to Norway.

For trade between EU member states further investigation on published statistics need to be made to determine which methodologies for estimation of value and if published data is following the general or the special trade system.

It is possible that differences partially can be explained by presentation of data according to general or special trade systems, as well as methods for estimating value. For trade within EU a margin of error is to be expected since the methodology using surveys is less reliable than toll declarations that is used for trade with non-EU countries.

For this comparison the value has been converted to SEK, based on currency values as of 2022-10-03. Even though the currency value rate can vary considerably, it cannot explain the major differences between the various national statistics. Further analysis needs to be done to evaluate these differences.

Table 3 Foreign trade (million tonnes) SITC, 2021

Weight (million tonnes)				
	Statistic source			
Trade relation	**scb.se**	**tulli.fi**	**ssb.no**	**statbank.dk**
From SE to FI	7,8	7,8		
From FI to SE	8,6	5,7		
From SE to DK	6,3			7,2
From DK to SE	6,0			5,2
From SE to NO	8,1		7,1	
From NO to SE	23,5		19,8	
From FI to NO		0,9	0,9	
From NO to FI		2,8	2,6	
From FI to DK		0,9		1,0
From DK to FI		0,6		0,6
From NO to DK			8,9	8,1
From DK to NO			2,0	2,1

Table 4 Foreign trade (billion SEK) SITC, 2021

Value (billion SEK)*				
	Statistic source			
Trade relation	**scb.se**	**tulli.fi**	**ssb.no**	**statbank.dk**
From SE to FI	111,7	91,0		
From FI to SE	67,4	76,8		
From SE to DK	122,0			285,8
From DK to SE	101,7			140,6
From SE to NO	175,4		100,7	
From NO to SE	172,0		113,6	
From FI to NO		19,0	15,6	
From NO to FI		18,5	18,2	
From FI to DK		13,5		14,4
From DK to FI		18,7		21,7
From NO to DK			39,9	42,9
From DK to NO			40,2	65,8

*DKR, NKR and EUR have been converted to SEK 2022-10-03

The Combined Nomenclature (CN) is used by all EU countries in their foreign trade statistics for goods, and also in the EU's Common Customs Tariff. Statistics are available for Sweden, Finland and Denmark, but not for Norway.

Statistics are presented as monetary value, weight and country. CN8 is the most detailed level of commodity classification in foreign trade statistics. In 2017, there were approximately 9,500 commodity groups. The nomenclature is amended annually and the nomenclature that enters into force at the beginning of the following year is published each year by the end of October at the latest.

Other classifications available in Denmark, Finland and Norway, but *not in Sweden* are:

- CPA, Classification of Products by Activities (value)
- BEC, Classification by Broad Economic Categories (value) of the UN is based on SITC-nomenclature and is aggregated according to the purpose of macroeconomic end-use categories.

Sweden provides available statistics in value with SITC and CN nomenclatures, divided into 265 commodities. Data is not regionalised. SPIN2015 is a Swedish nomenclature for commodities by branch. SPIN2015 is based on CPA (see above).

Norway stands out as it has available statistics at a far more detailed level than in other Nordic countries. Some tables are:

- Mainland export (value) by county and nine commodity groups. Based on SITC data.
- Foreign trade (value) by company branch and company size, with 45 commodity groups.
- Foreign trade (weight) by 64 commodity groups and 14 modes.
- Crude oil, before and after processing in Great Britain
- Export of fish
- Foreign trade with IKT commodities.

Denmark is the only Nordic country which publishes foreign trade with organic products. Statistics (value) can be extracted by country, or by 47 commodity groups, or by country and 17 SITC commodity groups.

The customs in **Finland** provide statistics that describe the values and weights for import and export according to the modes of transport and goods categories as well as by country of origin (imports) and destination (exports). The data has been classified by the modes of transport in accordance with the active vehicle crossing at the border. The statistical material even includes goods returned and those (to be) repaired. The transport statistics do not comprise of transit transports. The statistics on external trade container traffic include data on traffic between Finland and non-EU countries by country of departure (import) and by country of destination (export).

Transit transports contain information on road transport passing through Finland and across the eastern border across the most essential border crossing points (Vaalimaa, Nuijamaa, Niirala and Imatra). Statistics on eastbound road transit contain the transport weight of transit goods (kg) and their estimated value. Transit transport is compiled based on the CN-based combined commodity codes. Transit goods are not included in Finland’s international trade statistics.

The vehicles of land border stations are reported according to country of registration. As an exception, no country-specific data is available on passenger cars and buses. The vehicles and containers of sea border stations are itemised according to country of departure and dispatch. Empty and loaded trucks at sea border stations have been specified since 2015, before that, the empty trucks were included in the data on loaded trucks.

The data on passenger cars and trucks is recorded under the category for passenger cars and buses and are recorded under the category for empty truck concerning the land border-crossing points. At sea border-crossing points, buses are recorded separately.

3.2 Commodity flow surveys

3.2.1 National surveys

In **Sweden** commodity flow surveys (Varuflödesundersökningen, VFU) have been carried out five times between 2001 and 2021. As survey methodology has developed since 2001, the data-user needs to be aware of possible methodological differences when comparing results. The quality of the commodity flow survey might be further improved with the use of register data, thus becoming less dependent on individual company's willingness to answer surveys.[6] VFU provides knowledge about the freight transportation system and provide input to freight models and forecasts. Among data variables both weight and value (billing value) are collected. Commodity flow data are regionalized to counties and/or six road regions. The tables show e.g., foreign consignments divided by transport segment and country. Apart from prepared tables there is the possibility to combine parameters using the online service at *http://www.trafa.se/kommunikationsvanor/varufloden*.

A quick comparison between VFU 2021 and SITC shows some substantial differences between the values, where VFU 2021 show lower figures for both weight and value regarding trade between Sweden and neighbouring countries. The differences in methodology between SITC and VFU does explain differences in outcome. SITC investigate all trade monthly when VFU investigates a stratified selection on quarterly or yearly basis. The more thorough trade investigation (SITC) compared to VFU could indicate that the latter underestimates wight and specifically value in foreign trade.

A Commodity Flow Survey was carried out in **Norway** by SSB in 2015, and together with other data sources, form the basis of the commodity flow matrices representing the year 2016. The survey is not published on www.ssb.se and there is no official report available. It has not been possible to find information on whether the Norwegian survey will be repeated in the future.

There have not been any commodity flow surveys carried out in **Denmark,** nor in **Finland**. In February 2022, a digital seminar within the Nordic countries (except Iceland) concluded that the challenges of collecting data for public statistics and transport models are similar. Further collaboration between the countries is expected.

3.2.2 Regional surveys

Regional studies have been carried out using interviews and surveys of important businesses in the region or geographical area. Regional commodity flow surveys have been carried out in e.g., the Swedish regions of Västra Götaland and Skåne, Gävleborg, Mälardalen (five counties), Örebro municipality, and the Norwegian county of Tröndelag.

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[6] Varuflödesundersökningen – Effektivare datafångst. Trafikanalys, Trafikverket, Conlogic. 2022.

These studies have purchased data from business registers to try and estimate the amount of goods each company produces and consumes/attracts in a certain area. It is reminiscent of the Swedish Transport Administration's way of updating data for the demand matrices in the model. Register data and existing data are then supplemented with interview surveys aimed at the largest companies, with questions about how much freight departs and arrives at various businesses, how many vehicles are involved, etc. Truck surveys and other public statistics are also used as a basis.

An important purpose of these studies has been to show what goods flows look like in a certain region, where there are industries and terminals, and where people live. The regional studies carried out are ad-hoc and unique and cannot be compared due to the one-off definitions and methods used. The consequence of this is that the studies will be difficult to repeat, that the results from different studies will be difficult to compare and difficult to aggregate and combine with other suitable studies and thereby achieve economies of scale etc.

4. Traffic counts and surveys

This chapter describes the traffic counts and road transport surveys that are performed in all Nordic countries. Following the conclusions from a study of cabotage traffic and impacts on statistic quality of foreign registered vehicles. The quality of road transport surveys. Finally, new options gathering data from GPS is summarized.

4.1 Road transport counts

Experience from earlier studies suggest that there are discrepancies in traffic counts on either side of the international borders. For example, the traffic counts on the Swedish side differ from those on the Norwegian side despite there being no real reason for this (no significant industrial areas between the locations).

There could be differences in how the counts are measures, e.g., different minimum size of vehicle categories between car, light and heavy trucks. For any study of Nordic freight flows this difference will need to be investigated further and which values should to be used for comparison against the transport model. Accounted vehicles can also differ due to different time periods during the year for accounting, as well as different accounting years.

There are available traffic counts in all countries, measures in number of vehicles but not the number of tons transported. Conversion between tons and vehicles may need to be investigated further and average vehicle loads might not always be appropriate (e.g., volume-based packaged goods vs heavy raw materials).

For cross border heavy truck traffic, the Nordic countries provides on-line maps showing the number of heavy trucks on the road network at a yearly basis. The road transport flows can be found at:

- https://vtf.trafikverket.se/SeTrafikinformation.aspx
- https://vej08.vd.dk/stroemkort/nytui/kort/Stroemkort.html?id=201https://paikkatieto.vaylapilvi.fi
- https://www.vegvesen.no/trafikkdata/start/kart
- https://www.oresundsbron.com

Denmark also have a database on about 35 000 traffic counts called Mastra - They are published here: https://www.opendata.dk/vejdirektoratet/taellinger-nogletal-mastra but you need to map it yourself in GIS. The data has e.g, total average daily vehicles (AADT) and separated truck AADT (if it has been included in the count).

Furthermore, the Oresund Consortium provides statistics of number of trucks and vans (over 6 meter) passing over the Öresund bridge. For railway, there are available data on number of freight trains (summarised over both directions). The data is published at www.oresundsbron.com. Data on truck transport using ferries are captured in port and maritime statistics.

The border traffic statistics indicate the volumes of Finland’s border traffic according to vehicle and border-crossing point. The border crossing points are further grouped into border-crossing stations in Norway, Sweden and Russia, and separately into sea and land border stations. The vehicle statistics itemise passenger cars, buses, loaded trucks, empty trucks, loaded containers, empty containers, loaded semi-trailers and empty semi-trailers (only sea border stations). The statistics indicate vehicles arrived in and departed from Finland. The data is also grouped according to the countries where the vehicles have been registered or according to their country of destination/start whenever the information is available.

The actual number of vehicles is, of course, basic knowledge for any transport analysis. For each border-crossing point a more detailed analysis needs to be done to understand the reason for discrepancies in measurement data. Independently of the discrepancies between countries, traffic counts are useful to analyse historical trends of the development of truck traffic in each country.

4.2 National road transport surveys

The **Swedish** official statistics on truck transport includes Swedish registered trucks and trailers with max load weight 3,5 tonnes or more. Data is collected through an EU regulated survey and sent to 12 000 respondents. The statistics show traffic- and transport performance, transported volumes, and number of trucks. It is possible to select commodity group and transport between Sweden (eight load- and unloading regions) and other Nordic countries, including transit. For vehicle type there are information on weight, axle configuration and age of vehicles.

Danish statistics allow for weight, 20 commodities, import/export/transit and container/other modes. The statistics also allow for country (loading/unloading) and type of goods. There are 17 types divided by bulk, container and other units. The main variables are data on the vehicle, vehicle-kilometres, place of loading and unloading (by provinces), weight of goods, type of goods, kilometres driven, tonnes-kilometre and empty journeys. Danish statistics register trucks above 6 tonnes maximum permissible laden weight used for freight. Data are collected from a sample of road goods vehicles using the Danish register of motor vehicles as sample frame. Annually, approximately 8,000 vehicles are sampled.

Finland. The statistics on goods transport by road describe the transport activity of lorries registered in Finland for private and licensed transport in Finland and abroad. The data are collected with an inquiry from holders of lorries. The statistics includes 44 commodities, 20 commodity groups and nine types of cargo, transported with vehicles >3,5 tonnes.

Norwegian statistics have tables specifically for cross-border transport by truck measured in weight. Among the variables are origin and destination country divided by 20 commodity groups. The population for the survey consists of trucks in vehicle groups from the National Road Administration's motor vehicle register, with a payload of 3.5 tonnes and over and up to 35 tonnes in total weight and an age of less than 30 years. Vehicles for which it is not possible to assign an organization number for the owner are removed from the population before the sample is drawn. The total population consists of just under 40,000 goods vehicles.

4.3 Surveys of foreign registered trucks

In the truck transport market trucks registered in low-cost countries have become increasingly common. The statistics on foreign registered trucks and cabotage transport is defective.

SCB urges to interpret the official statistics on foreign registered trucks with caution because of different methods between countries to estimate truck transport and lack of information of illegal cabotage. [7]

The so called Cabotagestudien[8] have investigated movement of international vehicles in the Scandinavian countries to improve data on European freight transport, including illegal cabotage. The study concludes that:

- Denmark, Norway and Sweden are three different markets, with significant differences in terms of how cabotage and combined transportation are carried out.
- The actors in the market are very flexible and are adapting their businesses according to the possibilities the current road freight regulations offer. The Cabotage Directive may have been introduced to increase fill rate but is in practice viewed as a tool for gaining access to low-cost drivers on Scandinavian roads.
- The data for Sweden indicate that there are legal infringements of the cabotage rules, which means that trucks make more than 3 trips and/or stay longer than 7 days. There are also indications of frequent violations of tax rules regarding posted workers.
- Since Denmark is a small country with frequent Danish policy controls, there are few incentives and high risks for hauliers to take part in illegal cabotage.
- Due to limited number of observations in Norway, it is difficult to draw conclusions.

[7] https://www.trafa.se/globalassets/statistik/vagtrafik/utlandska-lastbilar/utlandska-lastbilstransporter-i-sverige-2020.pdf
[8] Sternberg, Henrik et al. (2015: Cabotagestudien. A study on trucking deregulation and cabotage in Scandinavia and beyond.

With respect to Cabotagestudien the truck transport data in Sweden seems significantly underestimated due to foreign registered vehicles while the foreign registered vehicles are less significant for the quality of truck transport statistics in Denmark. The data for Norway is not sufficient for conclusions and no similar study have been made in Finland. Due to Finland's geographical location it is reasonable to believe that underestimation due to foreign registered vehicles in Finland are less significant.

An indication on the extent of transport with foreign registered vehicles in Sweden can be the finding that Swedish registered vehicles transported on ferry primarily use Port of Malmö (17%), secondly Port of Helsingborg (13%) and thereafter the domestic ferry lines to Visby. In 2021 the number of trucks and trailers on ferry was around 248 000 via Malmö and 450 000 via Helsingborg. At Trelleborg and Ystad the ferries carried almost 1 200 000 truck/trailer units. Even without any calculations it is obvious that foreign registered vehicles dominate the cross-border transport with trucks in southern Sweden.

Foreign registered trucks are estimated to perform around 6% of the number of transports in Sweden, but around 20% of traffic and transport work. Since transport by foreign registered trucks is most likely underestimated the have significant impact on the representativeness in nation truck transport statistics.

4.4 Using GPS data for road traffic counts

GPS data is not limited by physical measurement points but generates data on the entire road network continuously. As all the data is stored in a database, preliminary studies can be carried out afterwards. Travel relationships, speed analyses and impact relationships of implemented measures can be extracted and analysed everywhere in any time up to real-time. GPS data can be regarded as a conclusion of how people travel and is a suitable tool to apply in traffic models, travel habit surveys and analyses regarding, for example, traffic safety and logistics. It can be applied in all work that includes how people move in the society and the road network.

Extracting position, movement and speed is not a new technology, but in recent years development has taken great strides towards the potential that the data has. It creates great potential to continuously extract data from vehicles and people using the infrastructure instead of relying on measurement stations positioned at selected road sections during a specific time. Observing data on a road stretch or in an area that does not have measuring equipment today is fast and efficient, compared to installing measuring equipment and waiting for results.

GPS data is position coordinates which are extracted from vehicles and associated sensors that are available. Each point contains a large amount of data suitable for different analyses. This means that the technology provides good conditions for visualizing and analysing how vehicles, in different vehicle classes based on weight or type (car, bus, truck, etc.), use the infrastructure.

All data is anonymised and complies with the GPDR. Trucks data can be extracted and analysed individually or in comparison with any other type of traffic to produce traffic volumes, route choices, speeds and more. Some examples of available data and associated analysis can be seen below, where the majority can be carried out for heavy traffic in different weight classes at any given time in recent years.

Table 5 Use cases for GPS data

Use cases for GPS-data	Data type and area of usage
Traffic safety	• Weather events – rain intensity • Slippery/Deteriorated roads – road segments with low road friction • Near misses - road segments with harsh braking • Over speeding - road segments with high instantaneous- and/or average speed and harsh cornering
Route analysis	• Turning ratios in an intersection or roundabout • Route choice and travel behaviour in an area • Distance, speed, travel time and vehicle category
O/D analysis	• Create Origin/Destination matrices based on zones or road stretches in an area • Distance, speed, travel time and vehicle category
Electrical vehicle fleet	• Fuel level/battery power level (state of charge) • Fuel type of vehicle • Studies related to charging infrastructure and/or electrical vehicle fleet
Asset management	• Road maintenance – road segments with low road friction • Detection of road signs

4.5 Maritime transport

Swedish port statistics are published by www.trafa.se. Imports and exports are shown by weight, 20 commodity groups and country for coastal regions. For each port: tonnes, TEU and number of units are shown by transport segment (Container/LoLo, RoRo and bulk). Sveriges Hamnar provides more detailed statistics (www.transportforetagen.se/om-oss/vara-branscher/transportforetagen-hamn/hamnstatistik/). Bulk is divided into crude oil, petroleum, other liquid, forest products, iron&steel, other dry bulk and other cargo. Unitised goods are divided by container, trailer and railway waggon.

Norwegian shipping statistics (www.ssb.se) show loaded/unloaded tonnes for each Norwegian port. The statistics are separated by domestic and foreign ports. Transport segments are Dry bulk, liquid bulk, trailer and container. The statistics are also divided into six commodity types and 36 transport segments. For freight by ferry, it is possible to select tonnes transported between specific Norwegian port and country, whereas Sweden is divided into North Sea and Baltic Sea.

From **Danish** shipping statistics it is possible to select data for each Danish port. International freight volumes (tonnes) can be selected by port, country of origin/destination or 21 transport segments. Country of origin/destination and transport segment can be selected only for Danish ports as a sum. Unitised goods are available as number and tonnes. The table shows loaded/unloaded goods by Danish port and 13 transport segments. The latter is one segment for RoRo and 12 container types (container size, with goods by size, empty by size).

From **Finland** shipping statistics it is possible to select data for each Finnish port and account for 17 commodity groups divided by trucks, trailers and other transport equipment. Containers are accounted for in number and TEU.

4.6 **Railway transport**

Cross-border freight flows on trains are more difficult to obtain as they are not officially available. However, comparison and validation are very important for the freight models. In some cases, the data might be number of trains, wagons or tonnes. Based on the allocation of freight trains on the railway network both number of freight trains and origin/destination can be identified. To be able to differ between waggon load and combi trains more detailed analysis needs to be done. Analysis of combi transport gets further complicated as combi waggons often are integrated in waggon load train system.

A more detailed statistics on freight transport by rail would improve the understanding and analysis possibilities. Desirable data would be train length, weight, type (system, waggon-load, and combi) and turnover data at marshalling yards and terminals.

5. Freight model inventory and selection

This chapter summarises which models have been included in the general inventory by country and which have been further analysed in more detail as they fulfil the pre-defined criteria. The inventory includes freight models that have been used for strategic freight studies and that have been discovered by the project team. Of course, there are certainly models developed for ad-hoc purposes in specific studies over the years that are not included in the screening, however they are not considered to fulfil the requirements for this study.

5.1 Overview of model developments

In Sweden many freight models have been developed and used in various studies over the past 40 years. In terms of strategic multimodal freight models, Sweden has been developing and using models since the mid 1990's with a STAN-based freight model, developed mainly for policy analysis such as the studies on port and terminal consolidation, testing of EU-policies on fuel costs etc. Development of the Samgods model started around the year 2000 in cooperation with the development of the Norwegian national freight model. It is therefore not unexpected that there are many conceptual similarities between these models, and that have inspired the Danish national freight model. At the time of development, the Swedish/Norwegian was amongst the most state-of the-art freight strategic models in the World.

Optimisation freight models have also been developed and used by multiple organisations over the years, many of which have been developed within academia and are not freely available, often undocumented, and usually include confidential data sources making it difficult to use for e.g., National Planning and official models. Flodéns HIT model was developed in 2008 and was an optimisation model between intermodal transport and trucks for a given demand. The demand was obtained by combining confidential data from private companies with raw data from the Swedish commodity flow survey. Other optimisation models have been developed and used such as the TAPAS model and many models developed at KTH in Sweden.

Denmark has several overlapping freight models being used at the same time. Two of these are regional models for Sjaelland, OTM and COMPASS, where trucks are included alongside the regional passenger model. These models are not multimodal. At a multimodal strategic level, the GORM model was developed in the mid 2000's and covered the area of Sjaelland in Denmark and Skåne in Sweden, with the aim of studying freight patterns and forecasts in the Öresund area. This model was not maintained, and later projects found that the model was unusable by the early 2010's and the model was put aside.

Finland has developed and used freight models, however as of today there is no official strategic freight model. Back in the 1990's and early 2000's there was a STAN-based freight model that was used for strategic analysis and policy assessment, but this was discarded over time and never replaced. Today there are development ideas and plans to develop a freight (and passenger) model, although it is still in its' early stages and there is uncertainty about how detailed it will be or how it will be fed with data. for this reason, we have selected to exclude descriptions about existing Finnish freight models.

Lastly, there are some European-wide models that include freight elements, namely TRANSTOOLS and the TRIMODE. TRANSTOOLS has not, to our understanding, been used or updated the past 5 years and our experience of the model is that it would be a worse option than the existing national models in the Nordics. The European Commission was responsible for the development of the European-wide passenger and freight model TRANSTOOLS between 2010 and 2017. The model system included a separate module for freight transport demand and a combined passenger and freight network assignment step. TRANSTOOLS was used on super-strategic studies in Europe as well as several studies in the Nordics such as the Baltic Transport Outlook, East-West Transport Corridor and TransBaltic. The freight model was at a very high zonal level (NUTS3) and gave questionable results when used in studies.

In 2018 a new European model development programme was started by the EU Commission to develop a new passenger and freight model. TRIMODE is undergoing development and could in the future be of interest, and therefore briefly described in this report.

TRIMODE is a multimodal European passenger and freight model that is currently under development. The model is not available for use by external organisations at the moment (EU internal tool only) and has very limited documentation. From the documentation is it possible to obtain the following description:

"TRIMODE (TRansport Integrated MODel of Europe) integrates a comprehensive European transport network model with state-of-the-art energy and economic models. TRIMODE is designed to represent in detail all transport movements on all freight and passenger modes across all of Europe at a NUTS 3 zonal scale, together with the economic structures that generate (and are affected by) this transport demand and the energy and environmental impacts that it creates."

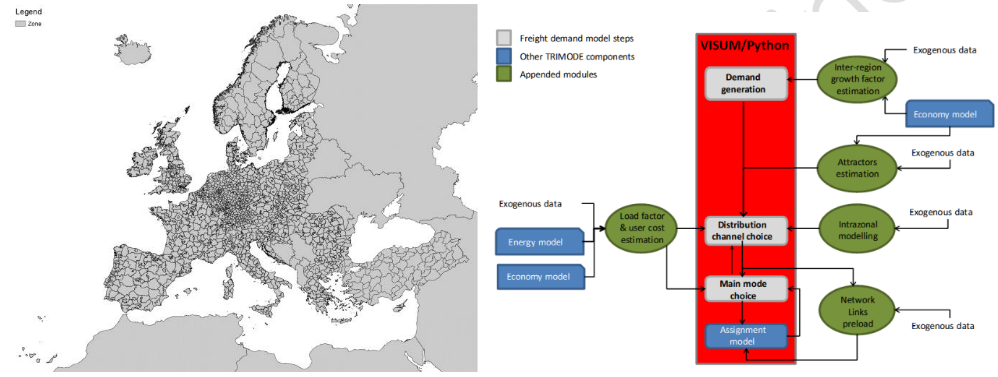

Figure 5 TRIMOVE zone system and overview

TRIMODE divides the demand into 18 commodities, based on NST2007, seven modes for maritime transport, three logistic leg types and six modes for land transport (14 component vehicle types).

Interesting to note is that TRIMODE uses the same general concept of freight demand as the Swedish, Norwegian, and Danish models. i.e., generate PC-matrices which are then run through a transport and logistics chain-choice step to produce vehicle OD-matrices and finally a vehicle-based assignment.

5.2 Selection of models for detailed analysis

For ease in the evaluation, the models have been grouped into "network models" - meaning that there are network-based elements in the models to e.g., calculate time/cost on the infrastructure, speeds on links, times in terminals, restrictions on the network etc – and "optimisation models" to specifically analyse specific transport chains.

Network models include Samgods [9] [10], National Freight Model (NGM), Grøn Mobilitetsmodel (GMM), TRANSTOOLS and TRIMODE as well as regional models such as OTM/COMPASS and redundant models such as GORM. Both latter models are road transport models covering Zealand and Öresund region respectively. HIT, Jensen, TAPAS and some models developed by KTH are among examples of optimisation models.

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[9] https://bransch.trafikverket.se/tjanster/system-och-verktyg/Prognos--och-analysverktyg/Samgods/

[10] https://bransch.trafikverket.se/contentassets/ab220f9016154ef7a8478555560bb280/2020/method-report-of-the-logistics-model-in-the-swedish-national-freight-model-system.pdf

Having evaluated the available freight models in the inventory phase, the following criteria have been used to evaluate the viability to use each model for strategic freight analysis based on their status today:

- Available to users and include official data/statistics
- Reasonably well updated
- Well documented
- Includes multi-modal alternatives
- Has been used for official studies/forecasts

Table 6 Inventory list of strategic multi-modal freight models

Model	Country	Available	Official	Updated	Doc	Multi-modal	Type
Samgods	SE	Y	Y	Y	Y	Y	Network
HIT	SE	Y				Y	Optimisation
Jensen	SE						Optimisation
TAPAS	SE						Optimisation
KTH	SE					Y	Optimisation
NGM	NO	Y	Y	Y	Y	Y	Network
SAMLAST	NO						
GMM	DK	Y	Y	Y	Y	Y	Network
GORM	DK/SE	N	Y	N	Y	Y	Network
OTM/COM PASS	DK	Y	Y	Y	Y		Network
SKEPRO	FI						Input-output
FRISBEE	FI					Y	Network
TRANS-TOOLS	EU	Y	Y		Y	Y	Network
TRIMODE	EU	?	Y	Y		Y	Network

With these criteria in mind, the conclusion reached is that only three freight models fulfil these requirements:

- The Samgods model, Sweden
- The Norwegian Freight Model (NGM), Norway
- The Grøn Mobilitetsmodel (GMM), Denmark

Only network models from the inventory list include multimodal alternatives. These models use a combination of modes and vehicle types to describe the restrictions, costs etc in the transport and logistics calculations.

Some models are older (i.e., not updated the past 15 years) or replaced by the models listed above. In the case of Denmark, there are more detailed truck-only regional freight models that have been disqualified in the evaluation process. The other freight models tend to be ad-hoc models for specific projects or research work. Several "optimisation" models have been developed over the years using often confidential data from e.g., private rail companies making it difficult for authorities to make use of the tools for official studies.

Online documentation of these model has been easy to find for Samgods and NGM. For GMM most of the documentation found has been related to the passenger model, or documents ten or more years old and therefore difficult to assess if our assumptions still hold true. Documentation on the freight part of TRIMODE has not been easy to find online, but some information has been received from the model developer in the form of presentation material.

Modelling software is an important factor influencing model availability. Both Samgods and NGM use the Cube software as a user interface and to coordinate/visualize data and results whereas GMM use tools developed by DTU. PTV Visum is the software used for the TRIMODE model.

5.2.1 **Bespoke transport chain model for Sweden**

Within the framework of this project, some optimisation models have been very briefly reviewed, such as the models developed by the Swedish Board of Transport (TPR), by Jensen (1987, 1990) and by the researcher Jonas Flodén's HIT model.

The first national model was built up by The Swedish Board of Transport (TPR) in the 1980s. It was further developed by KTH and used for in deep analysis by SJ Freight, KTH, Trafikverket and some national investigations until 2015. The model was built up of matrices for all transport modes. These matrices were coupled with the macro-economic forecast with input-output analysis that was break down in regions and a forecast of the value of commodities per tonnes. In a first step a reference forecast was done with the same modal split in each commodity group and O-D pair. Then the modal split could be reallocated with a logit model if the supply in terms of transport costs and transport times were expected to change. After that the matrixes could be assigned to the network and a judgement could be done if there was a need for increase of the capacity. A Nordic model with the same structure was developed in 1995 in cooperation with the Nordic railways.

The second strategic model was developed by professor emeritus Arne Jensen at the School of Business, Economics and Law in Gothenburg. The model is a strategic competitive model, which tries to determine the most efficient operating procedure of an intermodal transport system and its accompanying modal split. Focus in the heuristics is on the change of the total system cost incurred in the system. The Jensen model was implemented in the computer programming language Fortran and tested on a subset of the Swedish Intermodal market in the 1980s. For further information see Jensen (1990 and 2008).

The third model was developed by Jonas Flodén in 2008. The model HIT – Heuristics Intermodal Freight Transport Model (HIT). This model analyses in detail a pre-defined set of transport chain options and calculates solutions between trucks and intermodal railway alternatives. In the first version detailed input data from the Swedish Freight Transport Survey (VFU, 2004-2005), complemented by freight flow data from the Business sector, was used. This provided "fixed" OD matrices between Swedish municipalities, but did not include import, export, or transit.

The model developed by Flodén was written in C++ and comprised of information about e.g., the distance between municipalities instead of networks defined as links and nodes. Differentiation between commodity groups was not included in the model i.e., only total volumes.

On the face of it, this model doesn't seem to offer so much over the existing national freight models, however, some aspects could add useful insight into potentially modelling non-infrastructure measures. The benefit of this type of model would be flexibility, speed of running the models and maintenance.

6. Characteristics of selected Nordic models

This chapter describes the three national models used in Sweden, Norway and Denmark, and methodological features that unite and distinguishes the models.

6.1 The Swedish national freight model - Samgods

The national model for freight transportation in Sweden is called Samgods (the equivalent model for passenger transport is Sampers). The purpose of the model is to provide a tool for forecasting and planning of the transport system. Samgods can be used in policy analysis such as studying the effects of a tax change or a change in transport regulation etc as well as testing infrastructure and terminal measures. Samgods consists of several parts, where the transport and logistics module are the core of the model system.

The 16 commodity groups used in the Samgods model are based on the European Standard goods classification for transport statistics, NST 2007. Transport demand is described with commodity specific demand matrices for 588 geographical zones inside and outside Sweden, whereof 290 municipalities in Sweden. The model includes a zonal structure in the other Nordic countries corresponding to NUTS3[11]

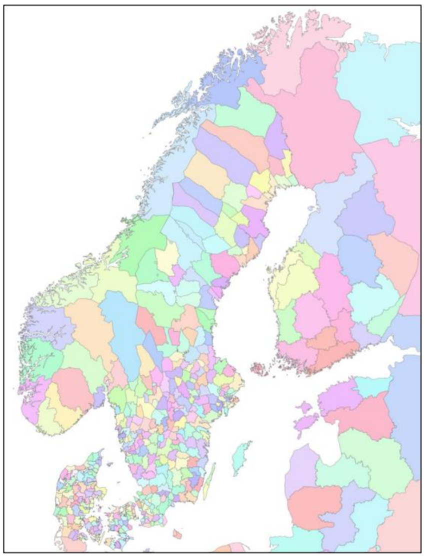

Figure 6 Samgods zone system

Demand between sending zones (production, wholesale) and receiving zones (consumption) is described with the help of production-wholesale-consumption (PWC) matrices. The logistics model produces mode-specific OD vehicle matrices.

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[11] https://ec.europa.eu/eurostat/web/nuts/background

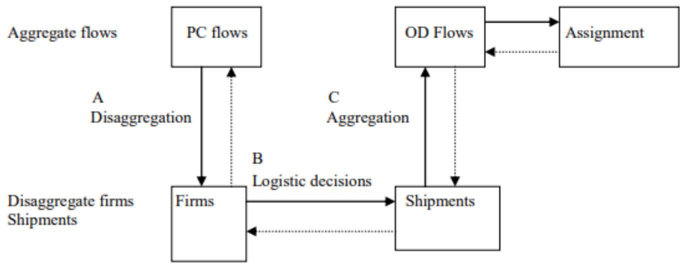

Figure 7 General concept of the Samgods transport and logistics model

Table 7 Commodity groups in Samgods

Commodity	Description
1	Products from agriculture, forestry and fishing
2	Coal, crude oil and natural gas
3	Ore, other products of extraction
4	Food, beverages and tobacco
5	Textiles, clothing, leather and leather goods
6	Wood and articles of wood and cork (excl. Furniture), pulp, paper and paper products, printed matter
7	Coal and refined petroleum products
8	Chemicals, chemical products, synthetic fibers, rubber and plastic products and nuclear fuel
9	Other non-metallic mineral products
10	Metal products excluding machinery and equipment
11	Machinery and instruments
12	Transport equipment
13	Other manufacturing ex furniture
14	Household waste, other waste and return raw material
15	Round timber
16	Air transport goods

Samgods includes modes for road, rail, sea and air freight. The model separates container and non-container flows and retains these throughout the entire transport chain solution. The concept of "modes" can be seen as separate and parallel systems with defined costs and restrictions. There are two road-based modes, one for heavy lorries up to 60 tonne and one for extra heavy lorries up to 74 tonne which has a more restricted network. There are six train modes including two intermodal modes, three wagonload trains (feeder, normal and long) and a mode for system trains. For sea vessels there are four separate modes, direct sea, feeder vessel, long-haul vessel, and inland waterways for shipping, and an extra two for road and for rail ferries. Lastly one mode for aircraft.

Each of the modes also have associated example vehicles to choose from with different characteristics, so there are many variations for the model to calculate. The Samgods model is very complicated and therefore we refer to the online documentation for further details on the model itself. The Samgods model is, as with most strategic transport models, focused mainly on infrastructure assessment, mostly step 4 (build new) measures, but also some step 3 measures (re-purpose).

In this report it is more important to briefly describe how Samgods has been applied and used for analysis and studies. The most obvious application is the official national forecasts[12]. These include an economic and demand forecast for the future as well as the inclusion of infrastructure according to the national infrastructure plan. Assumptions on e.g., fuels prices etc are also included in the forecast.

The forecast documentation includes, as well as the base forecast, some alternative scenarios giving an indication of how the model has been used:

- increased demand for iron ore
- lower growth in demand
- allow larger trucks (HGV74)
- longer trains

Figure 8 illustrates the Nordic cross-border freight flows by road/ferry from the Samgods model. In this analysis, only cross-border locations have been selected (using the selected-link model procedure) thus showing the combined flows of all starting and ending freight transport. The highest cross-border flows are between southern Sweden and Eastern Denmark and between western Sweden and southern Norway. As can be seen in the figure, there are significant truck flows along the entire corridor between Copenhagen and Oslo. The triangle Stockholm-Göteborg-Malmö can also be clearly seen amongst the Nordic cross-border flows connecting the capitals of all the Nordic countries, corresponding to the ScanMed Corridor.

Figure 9 shows the rail freight flows and the largest flows are seen on Malmbanan connecting northern Sweden and Norway with mainly iron ore. Elsewhere, rail freight flows can be seen to converge in southern Sweden and connecting Denmark and the continent via the ScanMed Corridor.

[12] http://trafikverket.diva-portal.org/smash/get/diva2:1442798/FULLTEXT03.pdf

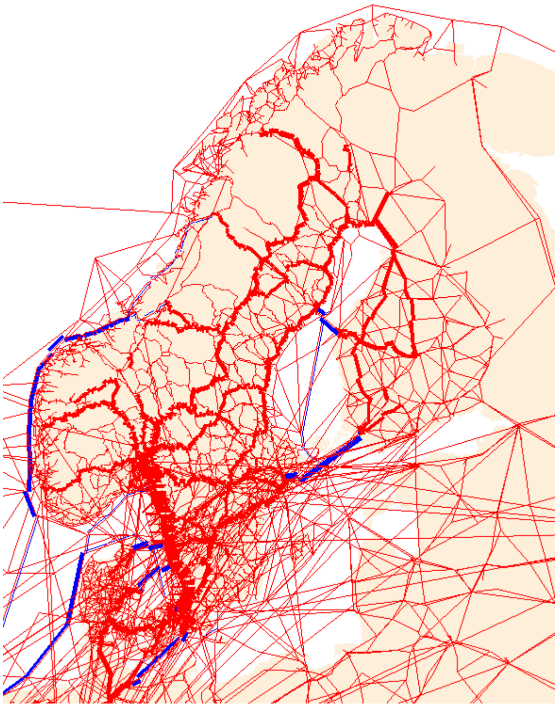

Figure 8 Freight flows by truck/ferry across the Swedish border (red=road, blue=ferry) Source: Samgods

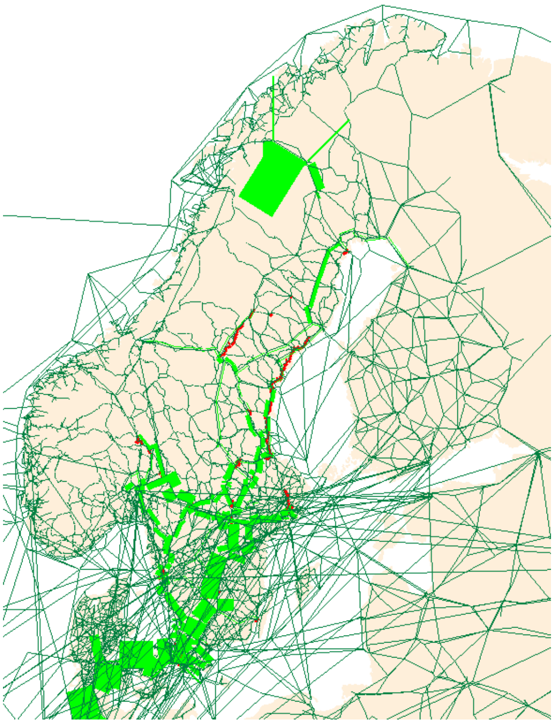

Figure 9 Freight flows by rail across the Swedish border (green=rail, red=road) Source: Samgods

6.2 The Norwegian national freight model - NGM

The Norwegian model (NGM) was developed in parallel with the Samgods model – both supported by RAND in the Netherlands. In essence the models are very similar, even if there were some obvious differences early on such as choice of commodity group aggregation. At one time it was discussed to use the same commodity groups in Samgods and NGM so that a Swedish-Norwegian (Nordic) model could potentially be possible, but this was never carried forward. Later develops in both countries mean that while the models are conceptually similar, they have many different characteristics.

The Norwegian NGM model uses municipalities as the standard zoning system, however, the six largest cities have sub-divided zones. Outside Norway neighbouring countries such as Sweden have several zones (Sweden has 13), other European countries have one each and one per continent outside Europe.

In total the NGM has 472 domestic zones (out of which 423 are zones for single municipalities, 43 are within the six largest cities, and the remaining twelve are zones representing large industry areas and offshore areas). Including terminals/yards and ports, the NGM has 1115 zones in the OD vehicle matrices.

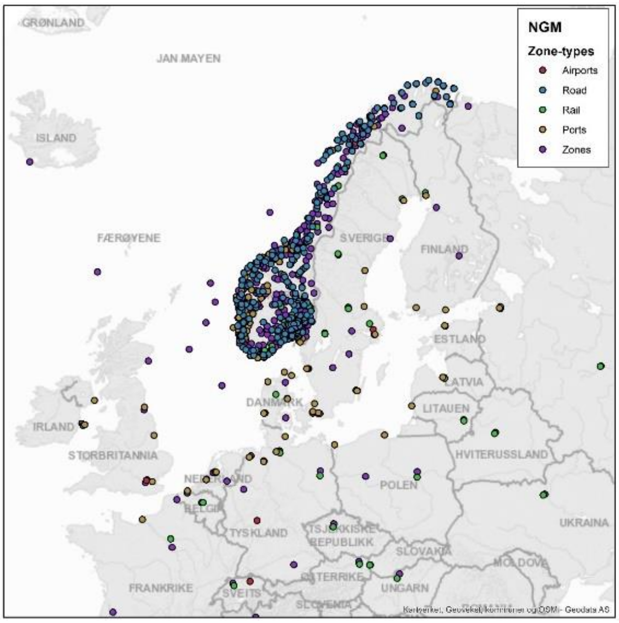

Figure 10 Norwegian NGM zone system

The NGM model uses two road modes (light and heavy lorries), one train mode, one sea and one ferry mode. Each of these has several vehicles associated with varying sizes and restrictions. For example, sea has many vehicle types broke down by container, break-bulk, dry-bulk, roro, reefer, tanker, gas tanker and their specialized vehicles. The NGM model is more "transport logistics-based" than the other models.

The NGM model uses mainly a combination of transport quality and "where in the transport chain (input goods or consumable goods)" as the main factor in the aggregation of its 39 commodity groups. This means that the NGM model is significantly different from the other models evaluated which use the NST commodity group system.

Table 8 Commodity groups in the NGM mode

		Varegruppering 1999		Varegruppering 2003 og 2008		Varegruppering 2012/2013 og 2014/2015
Varegruppering 1994: Stykkgods	1	Matvarer	1	Matvarer bulk	1	Jordbruksvarer
					10	Dyrefôr
			2	Matvarer konsum	8	Matvarer konsum
			3	Drikkevarer	9	Drikkevarer
	2	Fersk fisk	4	Fersk fisk	5	Fersk fisk og sjømat
	11	Frossen fisk	5	Frossen fisk	6	Fryst fisk og sjømat
	12	Bearbeidet fisk	6	Bearbeidet fisk	38	Bearbeidet fisk
	3	Termovarer	7	Termovarer, innsats	4	Innsatsvarer termo
			8	Termovarer, konsum	2	Frukt, grønt, blomster og planter
					7	Termovarer, konsum
	4	Maskiner og transportmidler	9	Maskiner og utstyr	26	Maskiner og verktøy
					27	Elektrisk utstyr
			10	Transportmidler	32	Transportmidler
	13	Høyverdivarer	11	Høyverdivarer	31	Høyverdivarer
	5	Div stykkgods	12	Levende dyr	3	Levende dyr
			13	Byggevarer	28	Byggevarer
			14	Diverse stykkgods, innsatsvarer	11	Organiske råvarer
					12	Andre råvarer
					17	Plast og gummi
			15	Diverse stykkgods, konsumvarer	30	Forbruksvarer
Tømmer og trelast	6	Tømmer og trelast	16	Sagtømmer	18	Tømmer og produkter
			17	Massevirke		fra skogbruk
			18	Flis og cellulose	20	Flis og tremasse
			19	Papir	21	Papir
			20	Trelast	19	Trelast og trevarer
			21	Trykksaker	22	Trykksaker
Annen bulk	7	Massevarer	22	Sand, grus og stein	24	Stein, sand, grus, pukk, leire
			23	Mineraler og malmer	23	Kull, torv og malm
					25	Mineraler
			24	Sement og kalk	29	Sement og kalk
			25	Massevarer	37	Avfall og gjenvinning
	8	Kjemiske produkter	26	Kjemiske produkter	16	Kjemiske produkter
			27	Gjødsel	39	Kunstgjødsel
	9	Metaller	28	Metaller	13	Jern og stål
					15	Metallvarer
			29	Aluminium	14	Andre metaller
Flytende bulk	10	Petroleum	30	Råolje	33	Petroleum uraffinert
			31	Naturgass	34	Naturgass
			32	Raffinerte produkter	35	Raffinerte petroleumsprodukter
					36	Bitumen

The NGM model has been used for many different types of scenarios, as well as for the official forecasts.[13] The table below shows which measures have been modelled, and an indication of how the model has been adjusted to take account of the measures.

Table 9 Measures previously modelled in NGM

Measure	Modelling-Approach
Introduction of new or moved terminals (3 projects, 60+ scenarios)	**New terminals coded into the network.**
Tested the effects of different localizations of rail-terminals: Including, effects of closing terminals, effects of levering costs for new terminals, upgrading existing terminals	Opening of alternative terminals for commodities which can use combi-modes. Adaption of transfer-costs to new assumptions for terminals given increased efficiency.
Testing of the effects of different freight measures	**Changes to link and mode properties**
Increased rail-length from 750 to 1000 meters	Cost-model adapted for longer rails
Increased maximum speed on double-rail from 120 to 160 kph	Rail speed changed on relevant links
Increased priority for freight-rail	Increased average speed for freight train
Electrifying rail stretches	Change rail type from diesel to electricity (cost-change)
Increased fuel cost and kilometre-tax	Simulated by increased fuel costs
Introducing modular vehicle combination	Simulated by the road links opened for modular vehicles
Effect of allowing EU inner marked in EØS-area	Simulated by lower driver-costs
Increase flows between main relations without increased user costs	Simulated by increased speed on roads, with or without changes in user costs represented by changes in diesel-fee
Changes to Low costs	Changes to Low-costs
Transfer of operating costs to central government	Removal of user-costs at traffic-centres
Subsidies per container freighted by sea	Simulated by reduction in terminal-costs
Increased train-length	Simulated by increased length for combi and wagon freight trains and timber-trains
Improved priority for freight-rail on al stretches	Modelled through increasing speed on all rail-stretches in the network
Sea-freight Measures	**Changes to cost-structure**
Removal for port-charges and subsidies of operating costs at ports for container goods within a cost-frame of 250 Mil. Nok.	Changes to the cost structure for ports in the model and for specific ship-types

[13] https://www.toi.no/getfile.php?mmfileid=44592

6.3 **The Danish national freight model – GMM**

The Danish GMM model, Grøn Mobilitetsmodel was first developed in 2009[14], and heavily influenced by Samgods/NGM in the design and concept of the GMM model. In very broad terms all three models are based on the same concept.

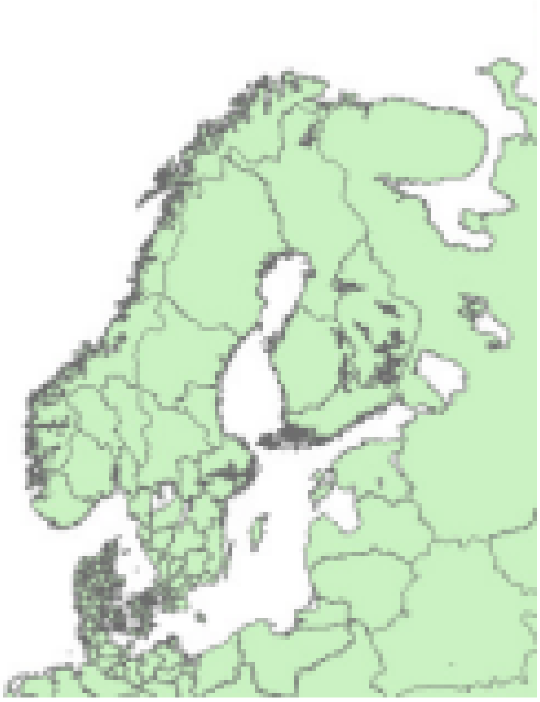

Figure 11 Danish GMM zone system

GMM Specific traffic terminals (airports, harbours, transport centres) are defined as individual zones according to importance. The freight model covers all transport flows which relates to Denmark or potentially could use Danish infrastructure.

Unlike Samgods and NGM, the GMM model is not a designated freight model and is heavily focused on the transport of people (car and passenger model), even if it also includes a freight model as shown in the diagram below.

[14] Before Octobre 2022 the model was named Landstrafikmodellen, LTM

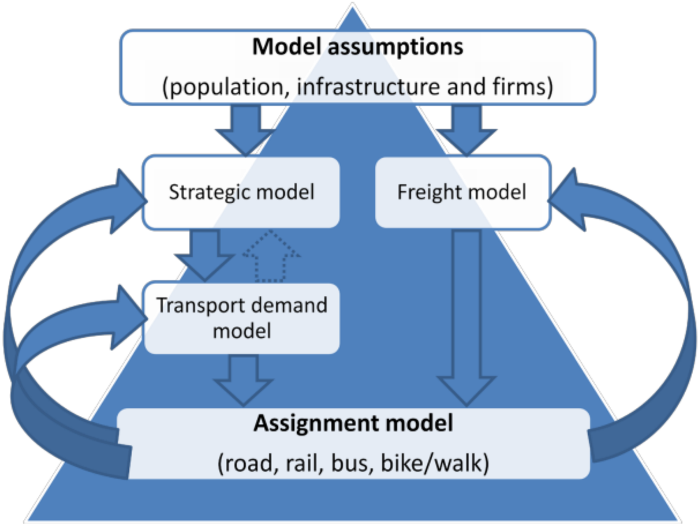

Figure 12 Danish model overview

For freight, three sub-models: trade model, logistics model, and route choice models

- **The trade model** aims to forecast trade between zones provided developments in international trade. The output is PWC matrices.
- **The logistics choices** in the model includes i) choice of frequency/shipment size, ii) choice of loading unit (e.g. containerised or not), iii) use of distribution centres, freight terminals, and ports, iv) mode used for each leg of the transport chain, and v) choice of crossing e.g. new Femern Bælt link. The aggregation of OD flows between firms to uni-modal OD flows between zones provides the result of the logistics model and input to the route choice models.
- **Route choice model** aims to assign the OD flows to the network as vehicle flows and is run at the same time as the assignment of passenger cars.

Table 10 Commodity groups in GMM model

ID	Beskrivelse
1	Produkter fra landbrug, jagt og skovbrug; fisk og fiskeprodukter
2	Stenkul og brunkul
3	Metalmalm samt uran og thorium
4	Fødevarer, drikkevarer og tobaksprodukter
5	Tekstiler og beklædningsartikler; læder og lædervarer
6	Træ og varer af træ og kork (undtagen møbler) papirmasse, papir og papirvarer
7	Koks og raffinerede mineralolieprodukter
8	Kemiske produkter og kemofibre (undtagen gødningsstoffer); gummi- og plastprodukter
9	Andre ikke-metalholdige mineralske produkter
10	Metal; færdige metalprodukter, undtagen maskiner og udstyr
11	Maskiner og udstyr i.a.n.; kontormaskiner og computere; elektriske maskiner og apparater
12	Transportmidler
13	Møbler; andre færdigvarer i.a.n.
14	Sekundære råmaterialer; kommunalt affald og andet affald
15	Breve, pakker
16	Udstyr og materiel til godstransport
17	Gods, der flyttes i forbindelse med privat flytning og kontorflytning
18	Samlegods: En blanding af forskellige typer gods, som transporteres samlet
21	Råolie og naturgas
22	Gødning (naturligt og kemisk)
23	Sten, sand, grus, ler, tørv, salt og andre produkter fra råstofudvinding i.a.n.

6.4 Freight model evaluation

6.4.1 Methodological features of the network freight transport models

The development and use of freight transport models differs significantly between the Nordic countries. Sweden and Norway have official models that were developed using the same basic methodology and concept of a combined transport and logistics model. Denmark later developed a national model after being somewhat inspired by the Swedish/Norwegian models. In Finland a high-level STAN-based model was developed in the 1990’s but today there are no strategic freight models in use. Of these, the Swedish Samgods and Norwegian NGM models, and potentially the Danish GMM model, are the most interesting for analysing long-distance cross-border intermodal analysis. Future development plans for all these models have been considered.

Samgods has made a step in this direction by including a division of container vs non-container. However, it does not divide the demand segments into these categories, only the choice and cost of transport chains. It would be essential to investigate and agree on a common commodity group system covering the whole of the Nordic region. This will also need to be supported by good and relevant input data for all countries[15].

[15] A report prepared for the Norwegian authorities, devoted to the future model development, lists possible data sources, including modern kinds of “passive” data (e.g., GPS data): C. S. Mjøsund, D. R.

The three National models Samgods, NGM and GMM all have “top-down” structures, meaning that they start with high-level strategic flows that are then disaggregated into flows between model zones. The models have a structure with PWC zones (municipalities in home country plus external zones) and after the logistics step additional node-zones representing terminals/ports etc. Samgods, NGM and GMM all generate and then assign OD matrices to mode-specific networks.

Even if the models are conceptually similar, they differ in details and functionality. Of these models, Samgods is probably the most complicated (in terms of the physical description of the networks and terminals etc) and given Sweden’s geographical location in the centre of the Nordic region it could be conceivable to expand Samgods to cover the Nordic Region.

Because of the functional differences, merging these models together would be tremendous task requiring significant time and resources. With that said, the information, data, inputs etc would be possible to re-use and to feed into a theoretical Nordic model in the future.

6.4.2 **Deterministic and cost minimisation models**

The NGM and Samgods are deterministic models, relying on a cost minimisation procedure. A deterministic model is relatively simple but has weaknesses that have direct implications on variety of policy measures that can be modelled and the model sensitivity to them.

The way transport agents behave in a deterministic model is not based on observed data representing behaviour of cargo owners, but on the assumption that they will choose the shipment size and transport chain that minimize costs under certain conditions related to transport networks, possible transhipment locations, expert knowledge of cost functions etc.

Therefore, such models represent unrealistic behaviour when freight transport agents make best cost-minimizing choices, possessing perfect information about all possible alternatives and their cost elements.

Another drawback of the deterministic approach is that many explanatory factors are not part of the calculated logistics costs and therefore are excluded from the logistics model (e.g., factors such as reliability and flexibility of modes).

Pinchasik, I. B. Hovi, Fremtidens godstransportmodeller. Litteraturgjennomgang og utviklingsområder. TØI rapport 1807/2020, available at: https://www.toi.no/getfile.php?mmfileid=55033

Finally, if the relevant part of the logistics costs function in a deterministic model is rather flat, only a small change in costs can result in a shift to a completely different optimal shipment size and transport chain.

Some of these issues can be solved by estimating disaggregate probabilistic choice models (e.g., Multinomial Logit Models based on random utility maximization theory) with available survey data.

While Norwegian and Swedish authorities are planning the shift to probabilistic (stochastic) choice models, the GMM contains a module for the choice of mode to cross the Fehmarn Belt screen line. This module uses a random utility model estimated on disaggregate data (including stated preference SP surveys in the Fehmarn Belt corridor). Other transport chains, for example in Denmark, are handled by a deterministic logistics model[16].

6.4.3 **Zoning and commodities**

All evaluated models use zonal systems using NUTS3 regions or a disaggregation of the NUTS-system. Samgods, NGM and GMM use municipality level zoning systems (sometimes with additional zones in more dense areas, terminals, ports etc) inside their own country and levels of aggregation close to NUTS3 in the other Nordic neighbouring countries.

However, it would be even more advantageous to have a more detailed zonal system to model transport chains more precisely. Municipality level might be an obvious choice, but this would mean a zonal system of around 1000 Nordic zones, plus external zones. When adding terminals, ports etc there could be around 4000 zones in total.

Samgods and GMM both use the EU official NST commodity group system, but with some adjustments (e.g., wood lumber is extracted from wood products and used as its' own commodity group in Samgods). The aggregation of commodities has changed several times over the past 25 years. For example, for Samgods it changed from "logistical families", to branch and now official EU aggregation. NGM uses a more logistical system.

The NST aggregation is easier to compare between countries as it is a European standard. On the other hand, transport quality and place in the logistical chain are vital components for modelling freight flows.

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[16] E. Caspersen, B. G. Johansen, I. B. Hovi, G. de Jong. Norwegian Logistics Model: Moving from a deterministic framework to a random utility model. TØI report 1538/2016. Available at: https://www.toi.no/getfile.php?mmfileid=43972

6.4.4 Applications and adaptations of the reviewed network models

It should be noted that most freight model analysis are carried out for new infrastructure assessment plans and are usually quite simple in character e.g., a new motorway to improve a twisting road along a given corridor, where an adjustment is made to the link distances and the link speed. Then the model run, and high-level results extracted in terms of link flows, ton (or vehicle) kilometres and perhaps automatically produced tables for a CBA-type of analysis. Sometimes this is even done with a fixed heavy vehicle matrix. So, whereas there is much experience, it is also limited in terms of analysing e.g., demand and optimisation measures. This type of non-standard experience is mostly in the hands of the few model developers or organizations heavily involved in the model development itself.

Some demand and optimisation measures have been analysed in Samgods by adaption of the standard model. These include adjustment of the standard time- and distance vehicle costs, as well as the vehicle maximum capacity and in some studies also adjustment of the track capacity in line with e.g., increased train speeds for intermodal transport to the same speed as passenger trains enables coordination in the timetable and therefore increased track capacity. A separate cost and capacity spreadsheet was developed for these studies specifically. Other adjustments of Samgods have been to add an extra intermodal "mode" in the model to represent the shuttle trains to/from the port of Göteborg.

6.4.5 A Norwegian example of data issues for more complex models

The purpose of a model is to give a simplified representation of reality which can be used to assess how the reality is likely to respond to changes/policies for a given set of assumptions. In the modelling process the benefits of simplicity versus complexity must always be weighed against each other. In weighing the two approaches, simplicity (in general) entails fewer variables and thereby more transparent results, at the cost of low levels of detail.

Complexity, on the other hand, may generate a more complex picture and higher level of details, but it is generally more difficult to assess what causes which effect, as there are more interconnected variables. The benefit of a simple model (compared to a more complex model) is therefore often given by the fact that simplicity gives simple results, and simple results are easier to assess for their accuracy, relevance, and deficiencies.

The challenge of adding to the complexity of a model is therefore often related to the associated data requirements. Adding a few variables to a model not only require data regarding the processes the cases represent, but also data that reflects the interconnection between the variables, which may often be skewed or non-linear. The data requirements from accurately increasing the complexity of a model may therefore grow by an order of magnitude, and this is especially true for an already complex model such as SAMLAST.

In assessing whether to increase the complexity of the SAMLAST-model, it is therefore important to carry out a thorough evaluation of the corresponding increase in the data requirements. An increase in the complexity of the model may entail a requirement for data on a higher level of detail than what is currently used or available. Accomplishing this may prove to be a highly complicated task.

An example of the complexity is the data-gathering process related to the current NGM. The freight transport study that provided the current matrices for the NGM was performed in 2014 and involved acquiring data from the 100 largest wholesale businesses and industries (measured by freight volume), and the 100 largest freight forwarders load aggregates. In addition to these, they also had to acquire data from other transport agents such as shipping companies and public agencies. Acquiring and processing the data related to both domestic and cross-border freight was therefore a major task, and entailed many challenges related to issues such as sample size, localization, classifications etc, which cumulatively added to the uncertainties connected to the acquired data[17].

This example shows that increasing the level of detail of the data requirements is not only likely to be difficult but is also likely to be connected to a wide range of measurements errors and statistical inaccuracies. This does not mean that it cannot be done, but it suggests that the effects of making any changes should be properly assessed before inclusion into the model.

[17] TØI rapport 1628/2018

7. Emissions from the transport system

This chapter describes the climate goals of the Paris agreement and the national reporting of emissions. Finally, methodology/tool to support environmental evaluation of supply chain emissions on company level is presented.

7.1 Regulations and reporting on climate goals

Each country that stands behind the Paris Agreement must submit a nationally decided climate plan. According to the Paris Agreement, countries must submit an updated climate plan every five years as part of the Paris Agreement's ambition cycle. The EU submits a jointly decided climate plan that all countries stand behind. This means that the EU has decided on climate targets that apply to the entire Union. Member states therefore does not submit its own nationally decided climate plan to the UN.

The EU parliament and Council have agreed[18] on reducing emissions of green-house gases (GHG) by 2030 with 40%, compared to the level 2005. The EU legislation results in a 50% reduction of GHG for Sweden, Finland and Denmark. Norway have signed the Paris agreement and joined the EU targets for reduction of GHG.

Policies related to sustainable mobility in Europe, fall inside the wider circle of NECP (National Energy and climate Plans), to meet EU's energy and climate targets for 2030. In this context, EU countries need to establish a 10-year integrated national energy and climate plan (NECP) for the period from 2021 to 2030[19]. The focus of these plans, is divided in various categories which are:

- energy efficiency.
- Renewables.
- greenhouse gas emissions reductions.
- Interconnections.
- research and innovation.
- sustainable mobility and transportation.

According to the United Nations Framework Convention on Climate Change (UNFCCC), parties are required to annually submit national inventories of anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol.

The National Inventory Reports (NIR)[20] are published yearly and contains national greenhouse gas inventories for the period from 1990. EU member states report to EU/Eurostat which in turn report to UN for entire EU.

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[18] https://www.europaportalen.se/2022/11/eus-nya-klimatmal-skarper-kraven-pa-sverige
[19] European Commission, "National Energy and Climate Plans", accessed 12 August 2022, https://energy.ec.europa.eu/topics/energy-strategy/national-energy-and-climate-plans-necps_en
[20] https://unfccc.int/

The fuel consumption and emissions for road traffic are allocated by fuel type and the following vehicle categories: passenger cars, light commercial vehicles (LCV), heavy goods vehicles (HGV), buses and mopeds & motorcycles. Emissions of CO2 from combustion of gasoline, diesel, ethanol and FAME/HVO are based on the fuel consumption, country-specific thermal values and national emission factors. As noted in the Cabotagestudien (see chapter 4.3), the Swedish statistics on freight traffic does not reflect actual traffic due to insufficient information on foreign registered vehicles.

In **Sweden** the responsible authority for producing climate statistics is Naturvårdsverket. The national emissions database[21] collects Sweden's national emissions of climate gases and air pollutants distributed by county and municipality level. The database enables the analysis of territorial emissions (county and municipality) of 26 different substances. For the sector "Transport", the data can be distributed across 11 emission sources, for example light and heavy trucks and railways.

Denmark. On behalf of the Ministry of the Environment and Food and the Ministry of Energy, Utilities and Climate, the Danish Centre for Environment and Energy (DCE), Aarhus University, is responsible for the calculation and reporting of the Danish national emission inventory to EU, the UNFCCC (United Nations Framework Convention on Climate Change).

Statistics **Finland** is the national entity with the overall responsibility for the compilation and finalisation of inventory reports and their submission to the UNFCCC Secretariat and the European Commission. Statistics Finland approves the inventory submissions to the EU, UNFCCC and the Kyoto Protocol independently.

Norway. The Norwegian Environment Agency, a directorate under the Norwegian Ministry of Climate and Environment, is responsible for the reporting. Statistics Norway has been the principal contributor.

The following two tables show emissions of greenhouse gases[22] during 2011 – 2020 from light and heavy duty trucks and buses according to Eurostat. There are no data for Finland. According to statistics emissions in Sweden from heavy duty vehicles have declined from 5,4 million tonnes to 3,7 million tonnes. The decline can most probably be explained by poor quality in Swedish data due to foreign registered vehicles.

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[21] https://www.smhi.se/data/miljo/nationella-emissionsdatabasen/nationella-emissionsdatabasen-1.174774
[22] CO2, N2O in CO2 equivalent, CH4 in CO2 equivalent, HFC in CO2 equivalent, PFC in CO2 equivalent, SF6 in CO2 equivalent, NF3 in CO2 equivalent

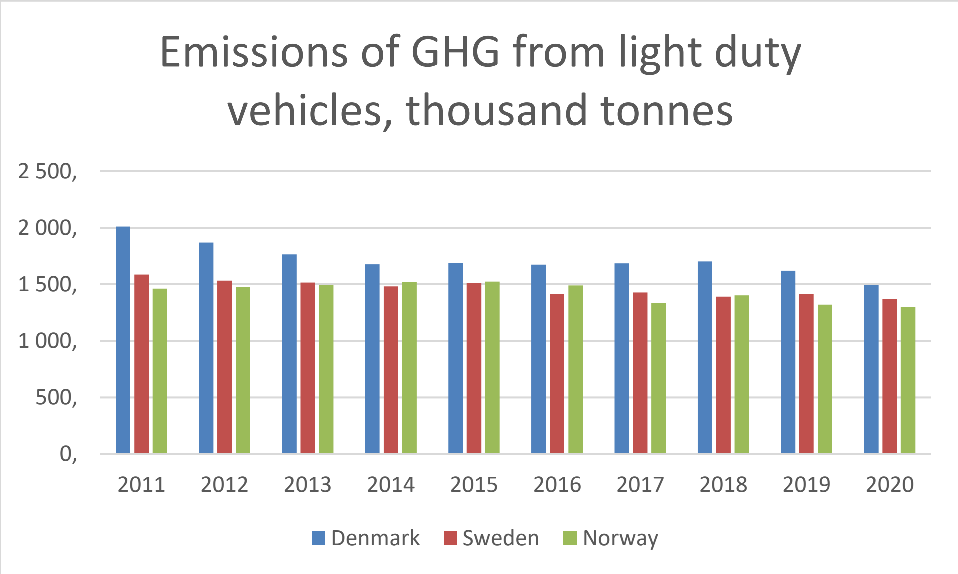

Figure 13 Emissions of greenhouse gases 2011 – 2020, from light duty trucks, thousand tonnes.
Source: Eurostat

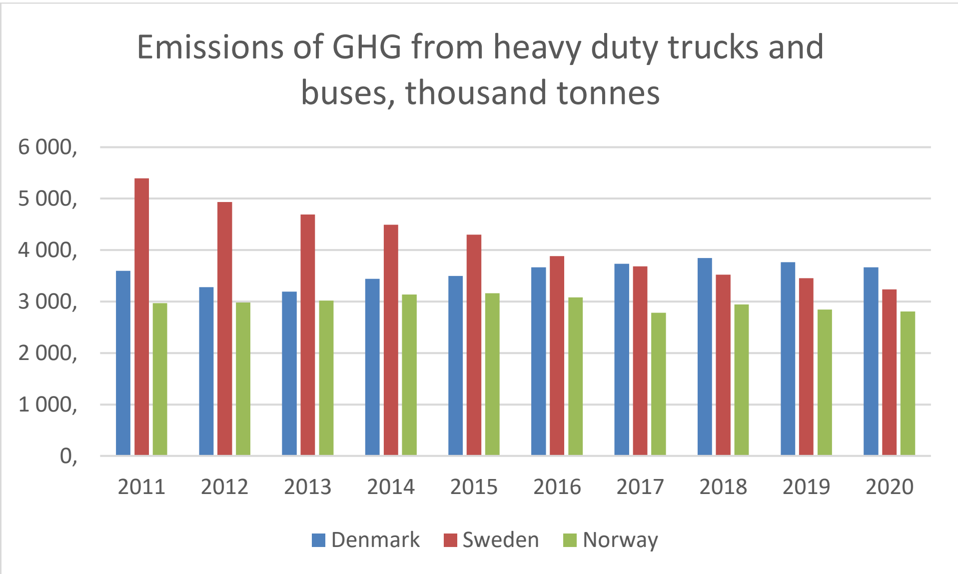

Figure 14 Emissions of greenhouse gases 2011 – 2020, from heavy duty trucks and buses, thousand tonnes.
Source: Eurostat

7.2 Supply chain emission accounting

7.2.1 The Global Emissions Council (GLEC)

The Global Logistics Emissions Council (GLEC), led by Smart Freight Centre[23], is a group of companies, associations, and programs, and backed by leading experts and other stakeholders. Its members include companies such as DHL, SNCF, Maersk, TNT, Hapag-Lloyd, & Kuehne + Nagel. Since its inception in 2014, GLEC developed a universal method for calculating logistics emissions[24] across road, rail, air, sea, inland waterways, and transhipment centres. The "GLEC Framework for Logistics Emissions Methodologies" combines existing methods into one framework and fills the gaps.

The Global Logistics Emissions Council Framework is the industry standard for calculating and reporting carbon emissions from freight transportation consistently across supply chains. The method is in alignment with Greenhouse Gas Protocol, Global Green Freight Action Plan, CDP, and the Science-Based Targets initiative. Companies can implement the GLEC Framework in different ways. Companies with developed accounting and reporting systems and dedicated staff can do this themselves. Companies that have less developed systems or are starting with emissions accounting can call in the help of SFC or SFC-accredited partners.

Many companies want to reliably calculate and report the GHG emissions associated with their freight transportation and logistics activities. More than 100 leading companies have committed to do so already, with the number increasing all the time; but how can you be sure that the calculation is truly based on the GLEC Framework or that the input data are up to scratch?

SFC checks the basis and outputs of a company's declared logistics GHG emissions in a given year against three core aspects of calculation and reporting:

1. Credibility and completeness of input data
2. Methodological conformance with the GLEC Framework
3. Reporting in line with the GLEC Declaration

Companies that want to validate the outputs of their logistics GHG emission calculation and reporting against the industry standard – the GLEC Framework – and to demonstrate this with confidence both internally and to their customers and external stakeholders.

[23] www.smartfreightcenter.org
[24] https://ghgprotocol.org/blog/glec-framework-universal-method-logistics-emissions-accounting

7.2.2 **The Network for Transport Measures (NTM)**

The Network for Transport Measures, NTM[25] is a non-profit organisation, initiated in 1993 aiming at establishing a common base of values on how to calculate the environmental performance for all various modes of traffic, including goods transport and passenger travel. To promote and develop the environmental work in the transport sector, the NTM acts for a common and accepted method for calculation of emissions, use of natural resources and other external effects from goods and passenger transport. The method is primarily developed for buyers and sellers of transport services, hence enabling evaluation of the environmental impact from their own transports.

To make a good estimate of exhaust emissions from road vehicles it is crucial as accurate as possible to specify the vehicle and fuel used, and other conditions that influence the emission levels. Therefore, NTMCalc offers the possibility to make a detailed description of these parameters for all transport modes.

NTMCalc provides fuel consumptions and pollutant emission factors for four different road vehicle types; heavy duty trucks, light duty trucks, heavy duty buses and passenger cars, where the first two are used for freight transports and the latter two are used for passenger transports. The vehicle types are further divided into sub segments representing different vehicle sizes. For all sub segments NTMCalc covers several emission standards, fuels, traffic situations and road gradients.

The weight-based load factor has a significant impact on both fuel consumption and pollutant emissions. This is of particular importance to consider for heavy duty vehicles, and therefore the NTMCalc database for heavy duty vehicles contains fuel consumption and emission factors for 100%, 50% and 0% load. The impacts on fuel consumption and emission factors to added weight are assumed to be linear from 0% to 50% load and from 50% to 100% load, respectively.

Users of NTMCalc has the possibility to specify several parameters: vehicle type, vehicle sub segment, emission standard, traffic situation, road gradient, fuel, cargo type, vehicle load capacity, cargo load factor, passenger load, fuel consumption, distance and cargo weight. The latter two parameters must be specified by the user. For all other parameters NTMCalc provides default data.

All emission factors and fuel consumptions for road vehicles are taken from the European road emission model HBEFA 3.1 (1). The traffic situations included in the first release of NTMCalc3.0 represent Swedish average road types as defined in HBEFA3.1. These are the same emission factor used in climate reporting to UN.

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[25] www.transportmeasures.org

The fuel consumption for a specific transport is calculated by multiplying the distance with the distance specific fuel consumption that corresponds to the vehicle, road type and load factor entered by the user. Pollutant emissions are calculated by multiplying the total fuel consumption with the fuel-specific emission factors in the NTMCalc database. The emissions of the fuel-related pollutants CO2 and SO2 are calculated from the total fuel consumption and the specified carbon and sulphur content of the fuel.

NTM members are engaged in several investigations with total or partially externally financing. Some examples of studies are:

- Compilation of case studies on occupancy rate (2020-2021)

During the fall of 2020 and spring of 2021, NTM compiles roughly 10 case studies that highlight the work of industry players to increase the filling rate in vehicles and ships. The study includes all types of traffic and must also describe the climate benefits of efficiency.

- Knowledge centre for electric traffic (2020-2022)

The project aims to compile and maintain an educational and easily accessible method guide and environmental database, which will also update NTMCalc with the electrified solutions of the future. By offering industry-wide data and tools for environmental analysis, the quantification and description of electrification's effects, both positive and more challenging, is enabled.

- Development of international standard, ISO 14 083 (2020-2023)

Through membership in SIS Technical Committee TK 207 – Environmental Management. NTM participates in the recently started project to establish an international standard, ISO 14 083 – Quantification and reporting of greenhouse gas emissions of transport operations.

- Conflicting regulations for fuel life cycle analyses (2020-2021)

IVL, with support from the Energy Agency and together with, among others, NTM, will analyse how different method choices in life cycle analyses (LCA) for fuels lead to conflicting recommendations regarding environmental improvements and fuel selection.

- Pilot with decision support for intermodal transport chains (2020-2021)

Maritimt Forum/Short Sea Promotion Centre and NTM are to develop an internet-based decision support when choosing intermodal short sea transport chains for goods flows (includes road, sea and rail). The goal is to establish a pilot system for how a digital decision support could be designed from the transport buyer's perspective.

8. Concluding discussion

This chapter discusses the availability and lack of statistic data, as well as modelling possibilities for re-think and optimisation measures including ideas for model development. Furthermore, the chapter discusses modelling of measures supporting intermodal transport. Finally, general conclusions are summarised in bullet points.

8.1 **Available statistics**

International trade statistics can provide us with information on weight and value for trade between the Nordic countries as well as commodities that are traded. Data is available on national level and does not in any country contain information on trade that are transited via third country. Thus, does not fully reflect physical transport.

There are several pitfalls in using trade data. First, there are uncertainties connected to the survey method used for trade within EU. Trade with non-EU countries is based on toll declarations. Trade value can be accounted for as statistic value or billing value. User of national trade data also need to be aware that there are two different principles that are used for presentation on trade data. The general principle includes country of manufacturer/seller and buyer, and the special trade principle which include goods that are warehoused in a third country. Eurostat is using the special trade principle.

There are discrepancies between different sources of trade data for the same trade relation. It is obvious that discrepancies occur when data is produced by survey, but in some cases the differences are very big and need to be explained. Deeper investigation will be needed to derive consistent datasets on a Nordic perspective.

Among the Nordic countries, Sweden is the only one with regular commodity flow surveys which are carried out with a few years interval. The tables show e.g., foreign consignments divided by transport segment and country. The surveys also result in weight and value (billing price) by commodity group and county. The questions included into the survey allow to include a limited number of variables into the model important for the choice of logistic solution. However, there are, for example, no information, on reliability and flexibility of the services used by the respondents. It is desirable to improve the quality of the surveys. For cross border transport the data on foreign trade can serve as a point of reference.

The traffic counts for road transport provide a stable and reliable source of actual and historical traffic flows with heavy trucks. However, traffic counts do not give information on O/D and commodities. The number of trucks on the road network is measured regularly in all countries, and the freight flow by truck in the national statistics is judged to be adequate and comparable. Discrepancies between the countries may occur due to year of measurement and time period. At comparing traffic count data at border crossing also must consider the location of the measurement point and possible domestic transport generation

Port statistics are often quite detailed, especially in Norwegian and Danish statistics. The least detailed statistics are from Sweden and form the common base for comparable statistics across the Nordics. The data includes a few transport segments that can be compared to commodity flow.

Freight flows by train are not officially available, even if the number of freight trains are possible to identify. It ought to be possible to estimate freight flows with some expert judgement, since cross-border freight transport by train is concentrated to Kiruna – Narvik, Copenhagen – Malmö and Oslo – Gothenburg/Arvika. It would be desirable with improved freight transport by train in particular regarding marshalling yards and terminals. Such data would improve the quality of transport modelling.

Road traffic surveys are (together with commodity flow surveys) the main source for road transport data including e.g origin/destination, vehicle types and commodities. The reliability of the data is dependent on the survey methodology which target domestic registered vehicles. A study has concluded that Swedish data lack data due to traffic with foreign registered vehicles. This significantly impacts the possibilities using these statistics for analysis, e.g environmental reporting. The study also concludes that the problem with foreign registered vehicles is less important in Denmark, and conclusions for Norway cannot be drawn. Any study for Finland has not been carried out.

Neither traffic counts, nor surveys provide information on micro level, that is on companies' logistic solutions. Thus, it is not possible to analyse specific logistic solutions for companies, nor for branches.

NTM provides the opportunity for companies to calculate environmental effects of different transport and logistic solutions. This opportunity could be valuable for analysing re-think and optimisation solutions but must be done in cooperation with specific companies or group of companies. The emission factors used in the calculation are the same as in the emission reporting all countries do to EU and UN.

The methodology for environmental reporting, according to the Paris agreement, is streamlined. EU members are obliged to report consistently due to EU regulation. This includes what to report, how to report and what emission factors are to be used. The methodology accepts national variations regarding emission factors. The quality is however not better then what the statistics allow in terms of produced traffic work. The problem with foreign registered vehicles in Sweden is illustrative since the reported sharp decline of emissions from heavy trucks is not consistent with traffic counts that show increasing traffic with heavy trucks.

8.2 **Modelling options**

The existing national models in Sweden, Norway and Denmark have the same overall methodology and structure of defining PWC flows and the using optimisation of the transport and logistics costs to assign the flows to transport chains to create mode-specific OD matrices, which are the assigned to the networks. There are some significant differences in the details, such as commodity groups, handling of rail capacity etc – but overall they are very similar.

The purpose of these models is to analyse infrastructure measures (mainly step 4 – re-build - measures) in a way that the measures can be compared with one another on the same basis, and that CBA and other assessment methods can be automated. The cycle of national infrastructure planning, which projects are economically viable to build are major applications of these national models.

An overall conclusion is that only measures that have direct transport cost effects can be modelled, then only if there is a solid basis for the cost changes and assumptions. When reviewing these models concern regarding the quality of the transport and logistical costs has been forthcoming. Given this uncertainty, care should be used in adjusting the modelled input costs.

An example is that there is an in-built assumption that companies have complete knowledge of the production and transport system, as well as a willingness to cooperate (consolidate shipments) with other companies. However, this is not the case, even if the current trend shows increase interest in these solutions. This would indicate that the rail costs in the model are underestimated, but then the model is balanced to get the "right" modal split in the validation/calibration phase meaning that the balance between the various input cost components could be quite wrong.

In short, the measures can be modelled by the current Nordic models only if they manifest itself in changes in the following model variables:

- Costs, both monetary and non-monetary, including time, distance, loading costs per vehicle type, pilot fees, product value, inventory costs, order costs, etc.
- Other level of service variables such as service frequency, speed, reliability / flexibility.
- Node characteristics: node availability, allowed transfers, direct access, container handling
- Load factors/ capacity of trains/vehicles/vessels
- Terminal/port cost factor (e.g., "technology factor" in Samgods)

The possibility to model the measures manifesting themselves in the variables listed above is conditioned by the fact if these variables are included in a particular model, which varies across all the Nordic models. Furthermore, most measures can only be analysed at traffic system level, and not for individual companies or group of companies.

There is no "general list" of exactly what measures can be modelled with the existing models. It also depends on the level of disaggregation at which this variable can change (e.g., if the variable can be set only for the entire network or per link, for each commodity group or for all commodities at once, etc.) E.g., train capacity restriction per link is available only in Samgods and that affects how the corresponding measures can be modelled, which will be presented in more details below.

8.3 Analysing re-thinking and optimisation measures

8.3.1 Freight owners

These measures include increased knowledge on production and logistics location, vertical liaison etc as noted earlier. In general terms these measures are very difficult to model as the existing Nordic models already assume that transport services are purchased from a full-knowledge and cost-minimizing perspective.

That is not to say that general global assumptions cannot in modelled at all, e.g., assumption that future cooperation between companies will increase in the future due to increased costs – thereby mitigating to some extent the general cost increase to only a 10% increase for all rail services. The problem with these assumptions is that they are not built on any statistics or data that is quantifiable. One study might assume an assumption, and another study a completely different assumption.

Input data and statistics do not exist, and any assumptions must be made by individuals or groups of experienced people with an understanding of the decision-makers situation.

To summarise, the existing national models are not built for analysing measures concerning freight owners' knowledge or behaviour and it is even questionable if such measures should even be included in any strategic model as they are often specific to individual company's conditions that change regularly.

On the other hand, optimisation tools and methodologies developed specifically for analysing individual transport relations, company and cross-company cooperation could be used with care. Input data and statistics for such analyses would be on a case-by-case basis and almost certainly require use of confidential data. Standardisation of the methodology could possibly be developed as a set of guidelines by the Nordic public authorities for transparency and less ad hoc assumptions.

8.3.2 **Transport and logistic services**

This category is to some extent possible to model, even if many measures are unsuitable for analysing in a strategic model since these cannot simulate alternative production systems. Existing terminals can be opened for specific transport modes and/or commodities (depending on the exact model). Although technically a challenge in some of the models, new terminals can theoretically be added to the models, along with supporting modal networks, to simulate new opportunities. The ease with which new terminals can be added, new modes or vehicles may differ between model applications and require different amount of development resources.

In general terms the following measures can be analysed with today's models:

- Opening access to new terminals for intermodal transport or within specific model networks/modes
- Assumptions on general cost changes due indirectly to more coordinated services.
- More optimal cooperation between companies resulting in lower costs for consolidation. Although it's uncertain how this can realistically be modelled with the current tools. The modelling of consolidation differs between models.

To be able to benefit from the spatial economies-of-scale in rail and sea, transport operators use different bundling models to consolidate freight flows. The network models (national models) can be used for analysing alternative transport routes and transport costs, and is often developed based on road transport characteristics, including routing and capacity restrictions.

The models can calculate alternative routes and means of transport on cost-minimizing principles however it is hard and time consuming to carry out analysis of bundling of sea and rail transport systems. The bundling systems include many planning functions. Controlling production based on criteria hard or impossible to model in general network models. Thus, the national models cannot fully depict and analyse sea and rail bundling functions and hence the production systems.

Input data and statistics are also a major barrier for carrying out these types of studies as little or no data/surveys exist today. Information on which terminals are open, their opening hours and conditions could be gathered and possibly be used in the models, we know that the terminal structure in some of the existing strategic models have old or deficient information on open terminals. How these terminal structures will look in 20-years' time can only be guessed/assumed.

Data for freight costs are always difficult to calculate, and how the costs are affected by changes in coordinated services/operation even more of a challenge. The main problem with the strategic models is that they have many general parameters and are not always suitable for diversity in geographies e.g., regional, corridors etc.

8.3.3 **Infrastructure optimisation**

This category includes both infrastructure optimisation and vehicular optimisation. Improvements in the transport system are often within a single mode of transport. Larger trucks allow for higher volumes to be transported by each vehicle thus reducing the number of trucks needed, resulting in reduced transport costs as well as benefits in lower congestion and reduced emissions. Improvements in rail or sea optimisation can lead to reduced costs, capacity utilisation improvements and potential shift to intermodal solutions (although not necessarily).

Some of the measures can be directly included in the strategic models, such as larger trucks, ERTMS (changes in running speed), new vehicles and crafts (reduced costs, higher capacity, better utilisation etc). Changes in general mode/vehicle costs to simulate larger trucks, longer trains, speed on links or reduced handling times through terminals and ports can be modelled in most of the national models. To what degree these changes can be made on specific locations (global, country, regional, corridor, link, terminals etc) and how modes/vehicles/commodities are defined varies between the various models.

A more detailed study of each model system would be needed to assess what exactly is possible on a measure-by-measure and model-by-model basis. Of all the models, the Samgods model is the most detailed, in terms of definition of modes, terminals, links etc and includes rail and road congestion calculations.

Even if some measures are possible (to some degree) other measures are more difficult to model. Supporting IT-systems, door-to-door solutions, changes in time-windows, management of nodes etc are not possible to model with the strategic models. Some of these measures could potentially be analysed using e.g., purpose-built optimisation tools.

8.3.4 **Policy and regulatory measures**

General costs based on policy such as km-charging for trucks and track fees for trains can be modelled in the existing models, and therefore adjusted in specific scenarios giving results with changed modal change, choice of vehicles or route choice. Likewise, pilot fees and fairway dues can be adjusted in e.g., Samgods.

However, the transport modes rail and sea are characterised by high system costs, i.e. the terminal and/or transport operator has the same level of costs independent of 10, 100 or 1000 units transported. When a decision is made to introduce a new transport system or transport service the operator will be exposed by high business risk until the operator has enough transport contracts to reach economical break even. Declining economies of scale cannot be modelled in the National Strategic Model and hence they cannot fully be used for analysing of multimodal policy measures. This more or less limits the area of utility to policy studies on transport markets in equilibrium.

In general, the model can be used för incremental changes on a market in equilibrium, i.e. small changes in cost structure and change of fuel supply system. However, for radical changes affecting the equilibrium or for incremental or radical changes initially hampered by inertia, the model cannot be used without additional studies.

Firstly, radical changes might result in system effects and dynamics affects affecting the equilibrium, which the model cannot handle. Secondly, new transport systems and new transport services need a sufficient market share implemented on a sufficient infrastructure network to be profitable (equilibrium), however the transition from existing technology to the next generation technology need to be supported. This new technology is in its initial phase seldom profitable only in niche markets or supported by subsidiaries and not under the present market conditions. This transition cannot be analysed by the National Transport Models, since the model is developed for analysing an implemented and mature transport system or transport service based on average costs.

All the evaluated models can model general policy measure that directly influence transport costs, such as changes in cost or even subsidies. The more detailed the policy measure is, the more challenging it will be to model the measure in detail. One example of this could be to have e.g., lower tax on cross-border intermodal transport within the Nordics, or lower tax on long-distance intermodal solutions – which would require model development.

Here are some examples of measures can be analysed with today's models:

- Fuel tax on all road vehicles (sub-divided by mode/vehicle/commodity)
- Rail track charges (sub-divided by mode/vehicle/commodity)
- Port fees and dues (sub-divided by mode/vehicle/commodity)
- Subsidies giving lower operative costs

Input data and statistics can already be used for some measures, as cost components such as fuel costs, fuel tax, rail track charges, port fees etc are already pre-defined parts of the existing costs e.g., the Swedish ASEK assumptions. Information on the sensitivity to changes for these components compared with the model would add quality and acceptance to the model results.

8.4 Measures that cannot be reasonably analysed with existing models

A general conclusion is that measures aimed at improving knowledge of freight owner's or transport service providers cannot really be modelled today, apart from some specific measures as described above. Technical solutions like IT systems to help with consolidation, to find return transport etc cannot be modelled either – even if some global assumptions can theoretically be changed, there is no data to back any of this up. Measures such as temporary financial subsidies, coordinated timetables, quality management, long-term planning etc are not suitable for analysing in a strategic model.

Some policy and regulatory measures can be modelled if they are in the same model-units as the existing models. A measure to alter the mixture of distance and time-based taxes by vehicle type etc may or may not be possible depending on the exact measure and the model.

Some infrastructure optimisation measures can to some extent be modelled today, but most measures listed in the beginning of this chapter cannot be modelled at all with today's tools.

To model the effects of foreign truck drivers on the Nordic market there are both modelling issues (how to differentiate how/where these transports are) and data issues (how to identify the transports and to define how this affects e.g., transport costs). Likewise, investigation of part of the truck market using driverless trucks, electric vehicles etc is very difficult at a strategic level. General assumptions on the vehicle fleet in determining an average cost are of course possible in the existing models.

The two major factors hindering analysis of certain measures are the limitations of the existing model structure and insufficient freight data availability and quality. The previous chapters describe these factors in details while this section summarises their implications to the policy measures modelling and analysis.

The model structure defines the variables that are included in the model and the relationships between the model inputs and outputs. These variables and the relationships, in turn, define what kind of measures can be modelled and analysed using the model.

All the three Nordic models have logistics module at the core taking into account the characteristics of the freight transport network, modes and vehicles, including costs, travel time, load factors / capacity and other characteristics mentioned in the previous section.

However, there are still variables important for the decision-making of the freight actors, but which are not included into the current models. Among those are, for example flexibility / reliability, especially important for modelling intermodal transport related measures, as the latter can substantially improve both flexibility and reliability and, therefore, make intermodal transport more attractive.

Similarly, variables representing freight forwarders' attitudes and heterogeneity among them (e.g., the level of knowledge about different logistics options) are not reflected in the current models, and therefore, the measures manifesting themselves through those variables cannot be modelled and analysed. As it was presented in the previous chapter, the current models imply perfect knowledge of all the options by the freight actors and their purely rational choices, taking into account the limited number of variables which are included into the model.

Modelling collaboration between companies or knowledge of transport service options is not possible in any of the models evaluated. Even with some adjustments and improvements this would still not be possible. The inclusion of these types of measures would require the development of new types of models and the necessary data and statistics to support the assumptions. Collecting such data to give consistent results over time would be more challenging than say average vehicle costs or terminal handling costs, and also be open to interpretation by the people answering the question.

Data quality and availability issues hinder analysis of some measures using the current Nordic models. The data availability in terms of variety of variables which can be included into the model is limited by the commodity flow surveys, at most. These limitations relate both to the freight alternatives characteristics (e.g., reliability of service) and firms' characteristics (only data on size and location is available currently).

Even less input data is available in the national models which do not rely on commodity flow surveys. So, if the commodity flow survey does not exist or exists but does not include, for example, questions allowing to reveal the level of knowledge of the logistics alternatives by the decision makers, then the model, which could take this into account, cannot be developed.

Even for the measures which are included in the list of those which can be modelled and analysed with the current models, this might not be the case due to insufficient data quality or outdated data of the existing models.

The outdated data or of insufficient quality might include various kinds of costs, the network representation, availability of modes and combinations of them, load factors, level of service characteristics, etc. For example, if the costs in the current model are not correct or some of them are not taken into account, the model will not be able to reflect the changes associated with introduction of a certain measure affecting those costs.

8.5 Some development ideas for modelling re-think and optimisation

Here are some examples of measures that can be modelled with the existing strategic models. The list is by no means all-inclusive, and the actual implementation will vary significantly between models.

Modelling re-think and optimisation measures using the existing versions of the Nordic national freight models could be performed only to a very limited extent, as already mentioned. The constraints are related both to the model structure and to data availability. And the possible ways of expanding the choice of measures include actions in several directions:

- Improving the existing models (or creation of one common model with a mode advanced model structure),
- Developing additional supporting models,
- Collecting necessary data to support those modelling efforts.

Speaking of the improvement of the existing models, more measures can be modelled relying on a probabilistic mode (chain) choice model which is currently planned to be implemented in Samgods and NGM, instead of the current logistics module.

To accommodate decision makers' attitudes (e.g., mode dependency of freight forwarders/carriers) latent class modification of the choice model can be used. To model heterogeneity in samples (e.g., accommodate differences in level of knowledge about intermodal services) hybrid choice models can be applied. The possibility to model different measures using this choice model would depend on the commodity flow survey data availability.

For example, modelling how the level of knowledge of different stakeholders affects the choice of the logistics solution will require having two samples of respondents (firms) from the commodity flow survey: one sample should include respondents which had some kind of "knowledge" about the intermodal solutions and the other sample would include the rest of the respondents.

For modelling the mode dependence of the freight forwarders/carriers using the choice model, the survey data must include additional questions, which would indicate that the respondents (firms) have such dependency.

Using the answers to these “indicating” questions and a latent class choice model structure would allow to take into account the factor of dependence in the model, as one of the “latent” variables, affecting the mode/chain utility, and therefore, the probability of the intermodal solution to be chosen.

All measures related to competition and cooperation (e.g., having commercially open intermodal transport system) can potentially lead to increased efficiency of freight transportation and therefore higher load factor.

Another consequence could be changes in the cost of the operators’ services, which can decrease due to increased competition or also increase due to the market players’ coalitions. In Samgods load factors and costs can be adjusted to accommodate the effect of cooperation or of lack of it. Empirical data would be needed on the possible variations of load factors and costs depending on the level of cooperation.

Such measures will also likely improve reliability/flexibility of the intermodal alternatives. Modelling changes in reliability and flexibility of the transportation services is not possible with the current versions of the Nordic models. These variables can be potentially included into the utility function specifications of logistics chains in a new probabilistic choice model version. Even if such variables are added to the model, some empirical data reflecting relationships between the commercial openness of the transport intermodal system and reliability and flexibility of the services would be necessary to model such relationships.

Another option to model measures related to competition / cooperation (or absence of cooperation) between different stakeholders (forwarders, carriers, etc.) is to develop an additional model based on the game theory.

These models allow to calculate both changes in profit of the market players and in the total consumer surplus. In such model the stakeholders can either solely or in a coalition change relevant parameters of their services such as costs, frequency, load factors, etc., until the equilibrium is reached, so that none of the stakeholders can benefit more (i.e., gain more profit) by changing the parameters.

To accommodate market’s reaction to the changes in such parameters the model should be connected with the logistics module of Samgods. This way, every time the stakeholders change the parameters, the corresponding reaction of the market in terms of freight alternative choice will define the flows and therefore the stakeholders’ profits. Based on that, the stakeholders will adjust the parameters again, and this will continue until the equilibrium is reached. For the development of the game theory-based model, additional detailed data on calculation of costs / profit of the stakeholders would be needed.

Using elasticities from other studies or bespoke models can also help in increasing the range of measures that can be modelled. For instance, elasticities reflecting changes in costs and reliability of the intermodal solutions because of changes in the level of cooperation or other interventions.

The proposed modifications which require changes in the commodity flow survey data are possible only for the next data collection occurrence since the commodity flow survey data is collected once in several years. Additionally, common considerations relevant to survey data collection, such as reasonable number of questions, which would not deter the respondent from responding the entire survey, should be kept in mind. To find the right balance between the number of questions and amount of information to be collected, pilot surveys should be applied with a smaller respondent group.

8.6 Cross-border modelling of multimodal measures

Here are some examples of measures that can be modelled with the existing strategic models. The list is by no means all-inclusive, and the actual implementation will vary significantly between models.

8.6.1 New train engines and wagons

The development of new generations of both engines and wagons will help to allow for higher rail speeds (assuming the track is up to standard) and large maximum loads per train. Higher speeds will facilitate better coordination of train slots (both passenger and freight trains) and thus improve capacity utilization on tracks with capacity issues.

Higher maximum loads per trains will allow more tons to be transported per train, with the benefit of carrying more tons by train but also to help reduce the unit cost per train (cost/ton) and therefore more competitive costs for intermodal transport compared with trucks.

The measure for longer trains with higher maximum loads which in turn facilitate lower unit-costs per transported ton. This can be modelled by adjusting the standard train costs in terms of cost per km and cost per hour.

In modelling terms, the following attributes can be adjusted:

- Rail link speed
- Rail capacity
- System-wide cost adjustments per mode/commodity per km
- System-wide cost adjustments per mode/commodity per hour
- Transfer costs/times at terminals

8.6.2 **Railway capacity restriction.**

Unlike the Norwegian and Danish freight models, Samgods includes capacity restrictions for rail by track (link). This is currently only done in the Swedish model, but there are development plans underway to include this in Samgods for the rest of Europe. The freight capacity is defined as the total capacity of the track minus the number of passenger trains (assumes passenger trains have priority).

In some of the models, e.g., Samgods, rail capacity is given as a constant. Passenger trains are assumed to have priority leaving a "freight train maximum capacity" value that is enforced in the model itself. Assumptions on new trains can be assumed with higher speeds which allow for better interaction with passenger trains and thereby indirectly helping to increase the theoretical capacity of specific links.

8.6.3 **New transport systems**

The models contain several different modes and vehicles, at least one per main mode (road, rail, sea and air), but many models include more detailed "modes" or restricted systems. For example, 30-ton axle trains are not able to run on the whole rail network. By clever use and definition of new systems it could be possible improve the existing models and even to model future systems, e.g., ScanMed Corridor. The concept can be extended potentially for any mode of transport.

8.6.4 **Single-direction train routes**

Coding of rail networks to be closer to real-life operations could also be an improvement. Some rail services use different tracks in one direction to the opposite. In this way the capacity restrictions can be mitigated by spreading the trains over several routes.

Input data and statistics do not exist today to support cost changes by mode/vehicle. However, support by the right experienced people could give indications of magnitude for assumptions in a way far easier than for freight owners or transport services. Some data can be calculated, even if challenging, such as rail track capacity.

8.7 **Possibilities for a Nordic freight model**

In order to have a Nordic-area based model is would be necessary to include high-quality data on rail capacity, but also to change the prioritization in the model so that a) International trains have highest priority, then national/regional/local passenger trains and finally national/regional/local freight trains.

Capacity restrictions for trucks are perhaps less important for a long-distance Nordic model as the flows are annual, or at least daily. For a Nordic perspective it might be necessary to include truck weight restrictions on the network if there are physical restrictions such as bridges etc. This can be modelled as separate networks or network restrictions by truck size category. For ports and ferry terminals the restriction should be based on the ship size category in the fairways/ports.

Other data collecting and validating efforts aiming at developing a common Nordic database can potentially contribute to the range of measures that can be analysed by the models (or one common Nordic model) and improve the quality of such analysis. This refers to the data on the costs and other freight alternatives' characteristics, network and modal data, etc.

8.8 Concluding remarks

8.8.1 What statistics and data are available?

- Foreign trade statistics have significant inconsistencies and needs further investigation.
- Commodity flow surveys important for modelling process but only carried out in Sweden and Norway. Inconsistencies between Commodity flow surveys and trade data.
- Road traffic counts widely available in all countries, but inconsistencies need to be investigated.
- Road traffic surveys are available in all countries. They are generally comparable but have all the disadvantages that comes with surveys.
- Port statistics generally good and detailed.
- Detailed rail data hard to obtain and/or confidential.
- Reliable and updated data on terminals and transport systems missing.
- Inconsistencies in cost parameters in the models.
- Consistent reporting of emissions, but questionable survey data quality.
- Company data that are crucial for analysing many re-think and optimisation measures are confidential.

8.8.2 How far can we come with existing tools/models?

- Most re-think and optimisation measures are hard or impossible to analyse with today's strategic models.
- Freight owners' choices, knowledge, decisions cannot be modelled with any of the existing models.
- Analysing transport and logistical services is for the most part not possible in the models, even with some creativity. Furthermore, there are practically no data sources (existing or obtainable) for supporting the implementation of the measures.
- Infrastructure and vehicle optimisation measures are to some degree possible to analyse. The strategic models have in-built functionality for some measures, but the vast majority of measures need to be cleverly weaved into the model system or are not possible at all.

- Policy and regulatory measures are in general possible to analyse, as they are general parameters in the models and directly influence transport and logistical costs. Measures to stimulate specific parts of the transport system or decision-makers are more difficult to analyse.
- The use of alternative tools, such as optimisation models, can analyse a wider set of re-think and optimisation measures than the general strategic network models. However, they tend to be ad-hoc tools using confidential data regarding company's business systems. They tend therefore to be non-transparent, one-off and ad-hoc tools which are difficult for public authorities to use for the basis of strategic analysis.
- NTMCalc provide a method for evaluating environmental impacts of measures in the supply change. This however is dependent on confidential data regarding company's business systems and cannot be generalized to transport system level.

8.8.3 **What functionality is needed for future tools/models in order to carry out Nordic studies?**

- Assume that trade data, commodity flow surveys and count/port statistics are investigated, and constant data outputs produced.
- Although the current national models are based on similar basic methodologies, there are significant differences between the models in terms of functionality, details, costs etc. It would be a huge task to combine the models into a single model.
- Finland has no national freight model, so this would need to be added to any eventual models or tools.
- Consistent zoning and terminal structure.
- Commodity groups are currently inconsistent between the country models.
- Modes/vehicles/network/terminals would need to be streamlined.
- Agreement would need to be reached regarding transport and logistical costs across the Nordic area.
- Guidelines and recommendations would be needed for working alternative assumptions, how to implement new measures etc.
- A combination of staff familiar with the models/tools/assumptions/details and an organisation including people experienced with implementation and understanding of re-think and optimisation measures in the "real world". This would be necessary for both the measure definitions (inputs to the model) as well as analysis and interpretation of the results (outputs) as there is likely to be very little statistical basis for elasticities in the results.
- In specific cases it might be of interest to analyse in detail a particular corridor or transport relation. In such cases it could be possible to develop faster optimisation tools which could perhaps cover a wider range of measures.
- The issues of data confidentiality, transparency and methodology would need to be investigated and guidelines determined.

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