

Enhancing e-Commerce Network Optimisation Through Navigating Trade Incentives Across Asia

1. Project Description

The recent trend of e-commerce has led to a gradual change in the traditional sense of network optimisation. Amidst global competition, supply chain logistics providers face a rapidly changing e-commerce environment, with conflicting concepts of consolidation for economies of scale and deconsolidation for small volume online orders due to e-commerce increasing both supply chain complexity and overall cost. This project aims to explore tax incentives that e-commerce orders may benefit from, such as minimum quantity tax exemptions.

In most network modelling software, taxes and tariffs are often not well modelled. This project seeks to create a systematic approach to modelling taxes and tariffs to enhance network optimization routines, with e-commerce as the model problem.

Key Skillsets

Logistics Engineering & Supply Chain Modelling
Application of supply chain concepts in network design

International Trade
Research and analysis on international trade regulations

Operations Research
Applied understanding of OR techniques to develop tax routine

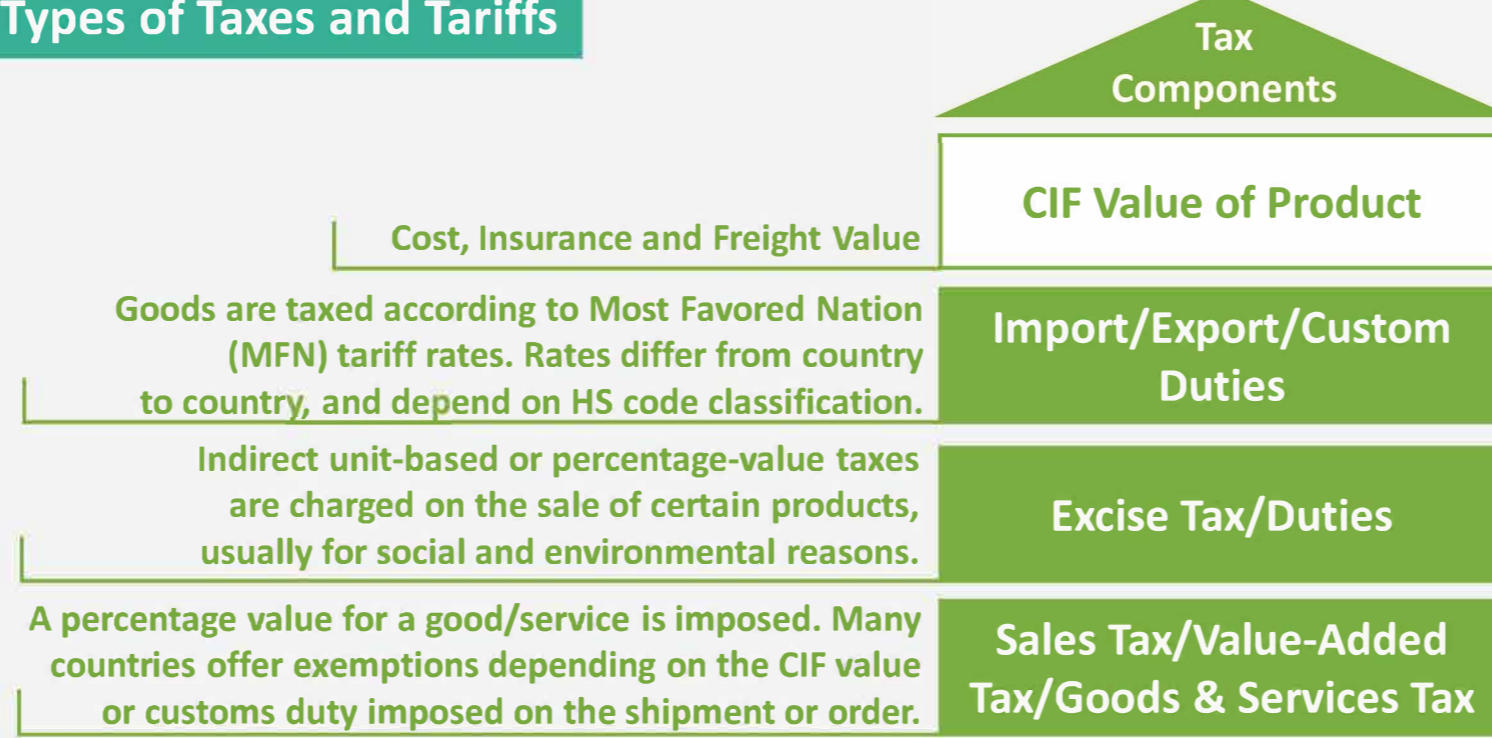
Microsoft Excel VBA, Python
Cleaning of unstructured data and actual implementation of tax cost generation subroutine

2. Key Objectives

- To construct a generalized trade taxation structure that best represents those employed in most of Asia.
- To develop subroutine enhancement to the company's network design optimisation model, allowing Toll to provide network design advice that is well-founded in terms of tax and tariff considerations.
- To assess the significance of the tax and tariff components in influencing decision making in network design

4. Industry Research

Types of Taxes and Tariffs



Free Trade Agreements

- Policies signed between two or more countries to boost trade
- **Rule of Origin**: conditions for imports/exports to be above some set percentage manufactured in participating country
 - Preferential tariff rates to be applied for custom duties if conditions are met

Free Trade Zones & Temporary Import Schemes

- Duties and taxes are suspended for re-exported goods in designated storage areas or during period of temporary import schemes
- Goods are not taxable until they enter customs territory

Harmonised System (HS) Code

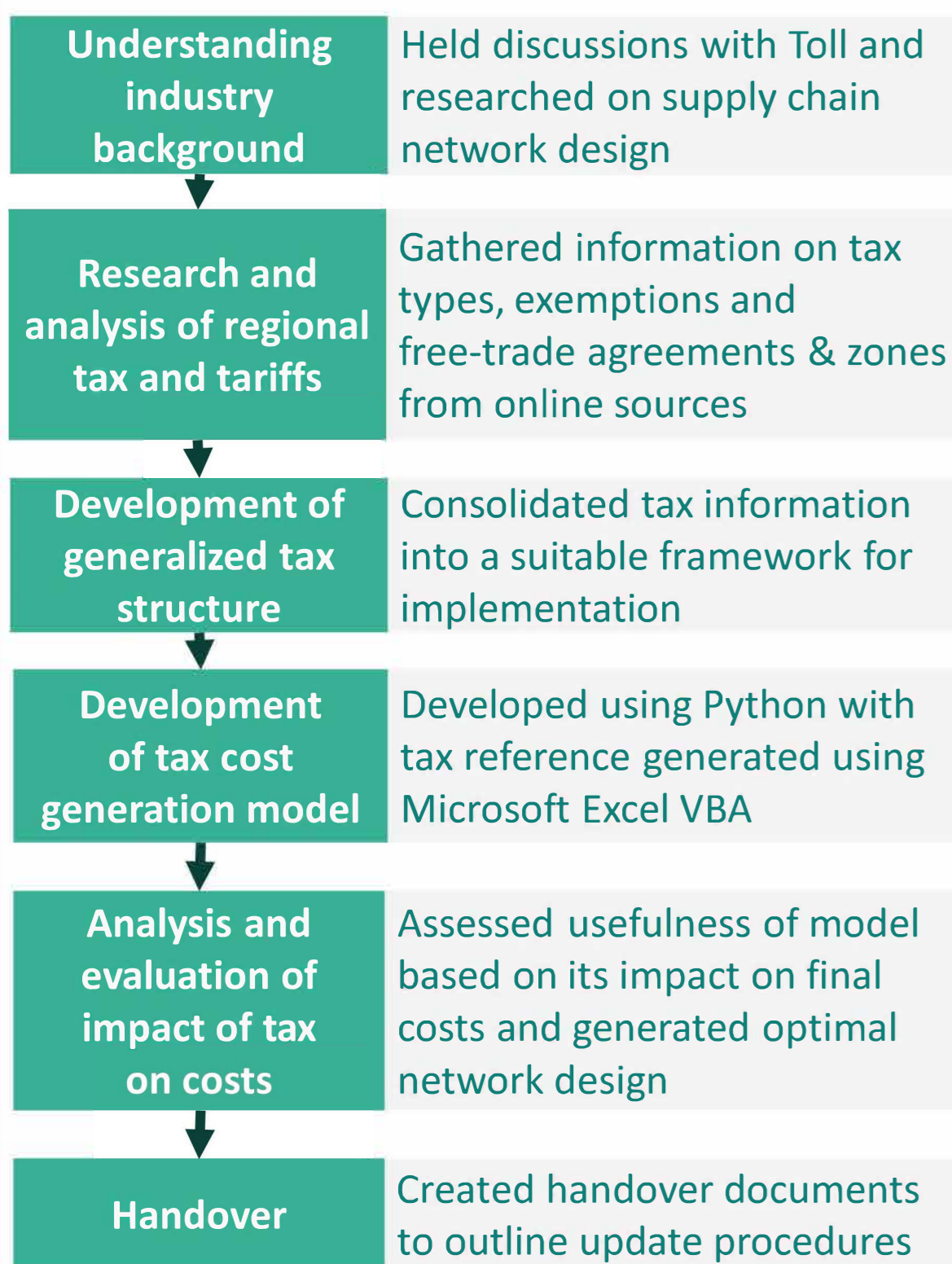
Classification system for tax purposes, where a commodity product group is represented using a number up to 10 digits



Tax Incentives and Exemptions

Singapore: GST waived if CIF value < SGD \$400 (USD \$304)
China: Tariffs waived if tax value < RMB \$50 (USD \$7.89)
Japan: Customs duty & GST waived if tax value < \$10,000 yen (USD \$93.60)
Korea: Customs duty and VAT waived if CIF value < KRW \$150,000 (USD \$141)

3. Methodology



5. Tax Analysis

Generalised Tax Structure

| Taxes & Tariffs | Free Trade Agreements (FTAs) | Free Trade Zones (FTZs) |
|-----------------------|--------------------------------|-------------------------|
| Import/Customs Duties | Countries | Countries |
| Sales Tax | Rule of Origin Requirement (%) | - |
| Excise Tax | New tariff rate | - |

Investigating Tax Through Visualisation

- Dutiable goods are exempt from MFN-based customs duties if FTAs are in place
- Hence, only ad-valorem based excise taxes are considered in illustrations
- Illustrations aim to find out trade stance of countries and which ones are more likely to be favourable hub locations

To-scale Excise Tax Illustration (ad-valorem)



6. Implementation

Referencing three-echelon supply chain

Objective Function:

$$\sum_i \sum_j \sum_k (transWC_{i,j,k} + whVar_{i,k}) d_{j,k} x_{i,j,k} + \sum_i \sum_j \sum_k (transPW_{i,l,k} + pVar_{i,k}) Z_{l,i,k} + \sum_i \sum_w whFix_{i,w} X_{i,w}$$

Variables:
 l Plant
 i Warehouse/Hub
 j Customer
 w Warehouse Type

$transWC_{i,j,k}$ Transport Costs from Warehouse i to Customer j for Product k
 $whVar_{i,k}$ Warehouse i variable cost for Product k
 $d_{j,k}$ Demand by Customer j for Product k
 $x_{i,j,k}$ Indicator variable if Warehouse i serves Customer j for Product k
 $transPW_{i,l,k}$ Transport Costs from Plant l to Warehouse i for Product k
 $pVar_{i,k}$ Plant l variable cost for Product k
 $Z_{l,i,k}$ Amount of Product k flowing from Plant l to Warehouse i
 $whFix_{i,w}$ Warehouse i variable cost for Product k
 $X_{i,w}$ Indicator variable if Warehouse i opened with option w

Considerations

- Managing complexity and efficiency vs. effectiveness of model
- MIP assumptions on additivity and proportionality
- Difficult to capture tax cost penalties as indexes

File Structure

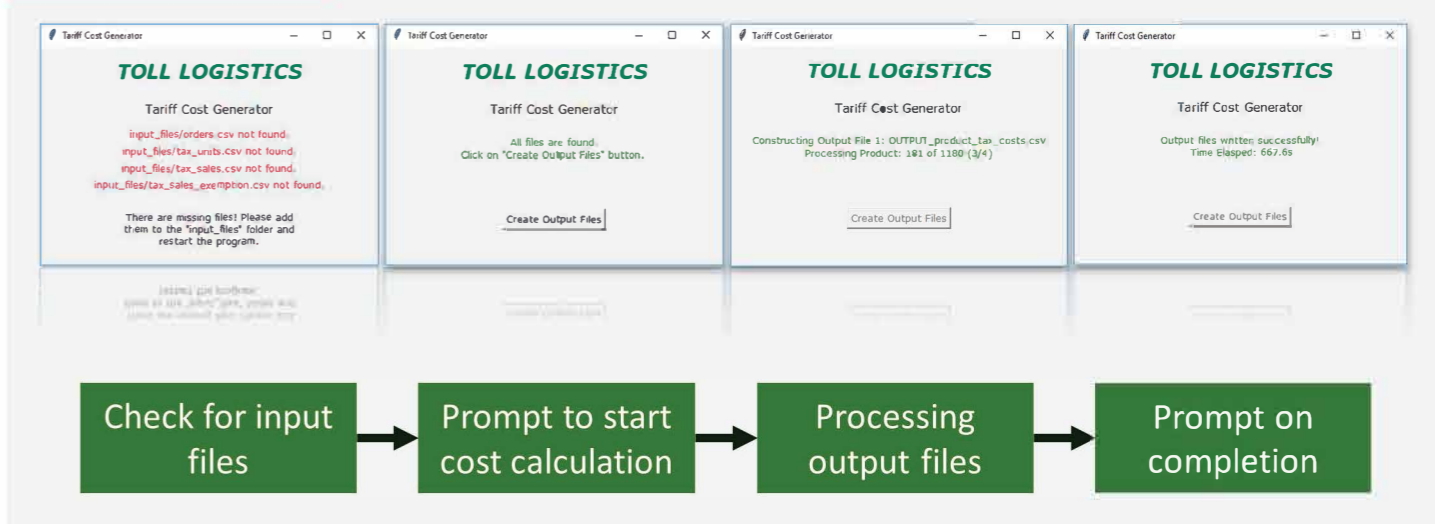
| Orders | Products | Sales Tax | Tariffs | Excise Tax | FTZs | Exemptions | FTAs |
|-------------------------------------|-----------------------------------|-----------------------|--------------------------------|--------------------------------|-------------|---|--|
| Order No., Product Mix, Destination | SKU, HS Code, Origin, Sales Price | Destination, Tax Cost | Destination, HS Code, Tax/Unit | Destination, HS Code, Tax/Unit | Destination | Destination, Type (CIF Value, Tax Value), Value | Origin, Destination, HS Code, Type (New value/% change), Value |

Outputs

Order-level Tax Cost
Order No., Total CIF Value, Destination, Sales & Customs Tax for Origin and Destination

Product-level Tax Cost
SKU, Unit tax cost at origin for imports and re-exports, Unit tax cost at destination for imports and re-exports

Program UI

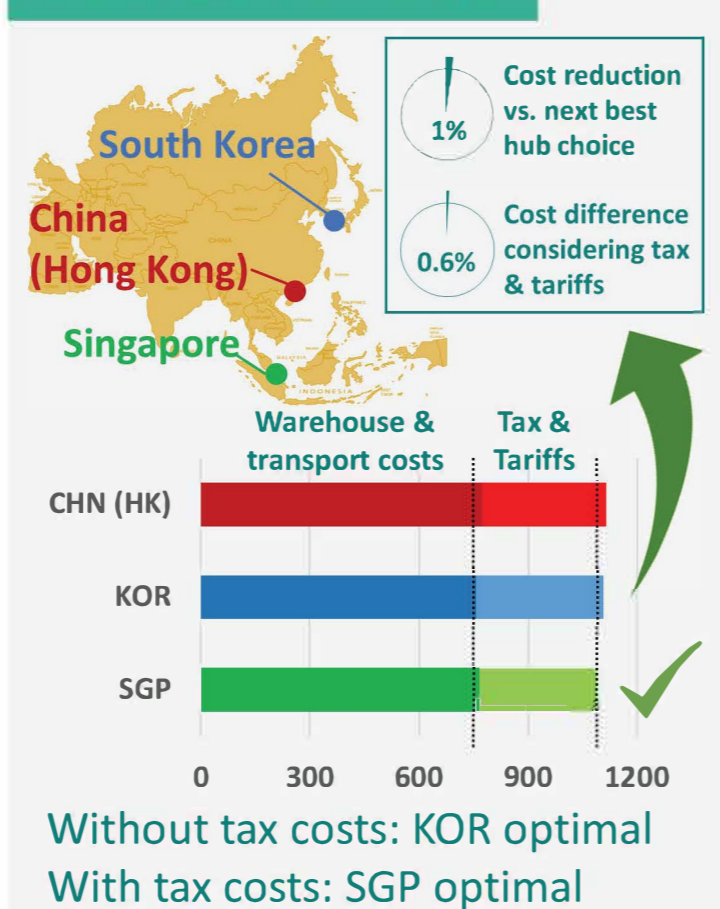


7. Results and Analysis

Case Study

- Product data from Client H, a health products marketplace operator from the US, is used to run the tax calculation model
- Client H previously decided to locate its hub in South Korea, even though Toll had advised H that Singapore is the best hub location choice.
- H might not have sufficiently understood tax costs in Singapore, and hence was hesitant to take the risk of incurring additional costs from tax and tariffs from Singapore's GST rates.

Illustration of Results



Analysis

- Generally low tax impact on cost by re-export goods compared to warehousing and transport costs due to waivers from Free Trade Zones and Temporary Import Schemes
- Tax and tariff costs are relatively consistent between hub choices, hence they have little impact on optimality
- However, for products that face high tariffs in certain countries due to protectionist trade policies (refer to illustration in Section 5), impact on total costs become more significant and can affect relative hub optimality
- Client H is worse off to choose other hubs from Singapore because of tax risk concerns
 - **Being informed on tax impact can help Client H avoid incurring more cost unnecessarily**

8. Future Work

- Incorporating tax and tariff calculations into the optimisation algorithm
- Automate the updating of sources of tax information and FTAs
- Dynamic scenario modelling to allow customers to look at revenue structure and management
- Investigate into areas with greatest potential for cost improvement
- Investigate into scenarios involving complex product compositions affecting Rule-of-Origin
- Include more detailed FTZ considerations