Solutions for Optimizing Customs and Border Processing - Streamlining Customs Risk Management Processes Through the Use of Artificial Intelligence

Submitted by: TTEK
SOLUTIONS FOR OPTIMIZING CUSTOMS AND BORDER PROCESSING

Streamlining Customs Risk Management Processes through the use of Artificial Intelligence

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The Customs Risk Assessment Cycle and where AI/ML can be incorporated

1. COLLECT
   - Take data in via advance reporting
   - Perform fusion and linking
   - Establish context
   - Establish domain awareness and supply chain visibility
   - Determine shipment position

2. ANALYZE
   - Bring together and organize a data set for triage
   - Measure trust, credibility, and integrity using transparency, character, and logic.
   - Determine type of threat
   - Assess likelihood (probability) vs. consequence (impact)
   - Identify low risk shipments and remove from data set (Facilitate)
   - Identify high risk shipments for closer scrutiny
   - Prioritize and rank shipments from highest to lowest risk

3. ACT
   - Weigh options
   - Make a decision based on:
     - Level of risk
     - Type of suspected threat
     - Resources/time available
     - Environment
     -Intensity of Inspection
   - Refer for Inspection
   - Take action (scan or inspection) to negate risk
   - Field analysis to confirm or negate reasons for referral
   - Intensity of inspection may increase/decrease
   - Record findings to measure success

4. ADAPT
   - Post analysis
   - Take findings and validate indicators
   - Update and fine tune the indicators
   - Re-risk score
   - Establish Predictive Models

1 2 3 4

Risk Assessment Cycle
Maturity assessment framework has been defined across five dimensions with top level being defined by best practices

Maturity assessment levels

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Advanced level – best practices</th>
<th>Basic level</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Collect</td>
<td>• Utilising more than 10 different relevant data sources including external/open-source data</td>
<td>• Utilizing declaration data and rudimentary inspection feedback</td>
</tr>
<tr>
<td>2 Analyze</td>
<td>• Advanced multi-variate models developed using time series, graph theory and more to model the entire supply chain</td>
<td>• Developed simple statistical models</td>
</tr>
<tr>
<td>3 Act</td>
<td>• Directly actionable high confidence findings forwarded to stakeholders in real-time. Results fully embedded within assessment business process</td>
<td>• Raw model specific results forwarded to stakeholders</td>
</tr>
<tr>
<td>4 Adapt</td>
<td>• Codified inspection results used to refine model development and informs future results</td>
<td>• Analysis of inspection feedback results and other intelligence informs model development</td>
</tr>
</tbody>
</table>
| Operational | • Data scientists and data analysts supported by software development teams and business analysts and leverage appropriate infrastructure  
• Models developed in an iterative manner using agile processes with highly structured collaboration with stakeholders | • Staffed with data scientists and data analysts |

Approximately 150 out of 178 Customs Administrations fit in this group
Collect – Establish domain awareness and supply chain visibility

As of today, many Customs Administrations leverage only the information received upon importer declaration and Bill(s) of lading, creating a lack of visibility throughout relevant supply-chain touchpoints.

In principle, supply chain information (i.e., traders and commodities) becomes more detailed later in the journey and closer to arrival.
Collect – Establish domain awareness and supply chain visibility

However, there is a large set of sources that can be leveraged to increase supply chain visibility

“Obtain the right data at the right time to make informed pre-arrival decisions to identify high risk shipments and containers while facilitating pre-approved and or low risk trade.”
There are multiple ways in which members can extend its domain awareness and supply chain visibility, some of which have already been started.

**Collect – Establish domain awareness and supply chain visibility**

Sources of information to increase visibility

<table>
<thead>
<tr>
<th>#</th>
<th>Source</th>
<th>Methodology to access and use the data</th>
<th>Source Methodology to access and use the data</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Manifests and Bills of Lading</td>
<td>• Customs will already be receiving this information pre-arrival of the goods. Fuse and correlate the related house bill of lading with the related declaration(s) to identify discrepancies in key data elements.</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Container Status Messages (CSM’s)</td>
<td>• Can be demanded from all carriers discharging cargo in the KSA as a matter of Government policy, or procured from an aggregator of global CSM’s. Note: for this to effectively work at scale; you need visibility of CSM’s across multiple carriers (at least 120+) for this process to work effectively at scale.</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Aggregated reported global commodity data</td>
<td>• Global aggregated trade statistics – Used to identify normal patterns of trade. i.e. what are common exports from each economy and where to they ship to? Irregular or large transactions can be compared to statistical trade data to identify if it falls within realistic statistical limits.</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Vessel and aircraft data</td>
<td>• Risk assess the transportation equipment. Identify sanctioned vessels or aircraft; or equipment with a poor operator history, or residing in a high risk economy. Check equipment routing to identify if vessels have ‘gone dark’ or ‘spoofing’ their AIS transponder which identifies their live position.</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Sanctions lists</td>
<td>• Utilise the frequently updated sanctions lists from other nations to identify companies, equipment or people of potential interest.</td>
<td></td>
</tr>
</tbody>
</table>

NOTE: Recommendations provided require availability of active software engineering development teams.
Goods descriptions data cleansing can be done through 1) use of general principles to remove misleading data and 2) methodological review of current models

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General principles and advice

- Remove stop words (i.e., words that are typically filtered out before processing a natural language). For example: “the”, “a”, “an”.
- Remove words or letter clusters that span many different tariff codes. (Count word vectors that appear in more than about 10 HS8 classification; and manually determine if they can be added to a set of words/ phrases for exclusion. Recommend not fully automating that step; as the number of words or phrases that fit this criteria should not be more than 4-500, so can be done manually as a one-off step, with occasional maintenance.
- Remove numbers greater than 1000 (generally…..) as larger numbers are typically describing quantities; not the goods themselves

Suggested methodology recommendations for further experimentation

- Using a pre-trained language model may be less effective than training the neural network using only goods descriptions, as word order of goods descriptions is atypical from normal sentence structure. (in any language)
- Don’t remove duplicates or similar descriptions from the training set – the sample size of a given description helps highlight the likelihood that the classification / valuation of a set is statistically correct (or all traders are biased towards one classification) Use this to your advantage to help determine the highest probability subset that a description can be grouped with.
- Repetitive data or description that cover many potential sets/ clusters.
  Determine if the repetitive sets are correlated to a certain HS code, or subset of codes. If the set is non-correlated with the codes; exclude the transactions. For example, descriptions as the below should be excluded from any analysis as phrases like the above are impossible to interpret:
  - General merchandise
  - Freight of all kinds
  - Said to contain
Entity names cleansing and canonicalization is fundamental to run more precise analyses without impacting the trade community

Challenges/ gaps

• A substantial number of rules operate on company names as various entities of the supply chain
• Subsidiaries, trading names and misspellings can obscure the true nature of an entity and avoid the entity triggering watch-lists and rules

Approach to consolidate

• Select an entity “canonical name” – see example on the right
• Run the derived data against your risk models to improve the quality of your results
• Show stakeholders both the declared name and the derived name. Cluster similar transactions based on the derived name to improve understanding and insights

Results: Effectively provides more precise entities without impacting the trading community, Participating Agencies, or changing policies, business processes or regulations.
Weights, quantities and values is a typical area of poor data quality given the multiple ways of expression, which can be avoided by performing validation checks.

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1 CHALLENGES/ GAPS

- Machine learning models operate poorly when trained against poor quality data. There are some key data fields which are important for multiple revenue models; therefore we have focused on some activities that the Advanced Analytics team can carry-out to help improve data quality. Implementing this is of huge benefit to the whole organisation; not just the revenue analytics team.
- Poor data quality in Customs is ‘normal’. Resolving this properly is a policy issue; but there are some things that an analytics team can do to help.

2 COMMON PROBLEM AREAS

- Units of Measure
- Goods Descriptions
- Exporter Names
- Customs Value for Duty
- Gross and Net Weights

3 RECOMMENDATIONS ON UNITS OF MEASURE

- Units of measure need to be correctly validated by the Customs system. There should be a 1:1 relationship between a tariff code and the tariff unit of measure, and any other units of measure applied to taxes.
- For example diesel tariff unit of measure is barrels; but excise may be applied per litre or per gallon. The Customs system needs to validate the applicable units of measure and flag declarations whose quantities appear irregular BEFORE the declaration has been submitted.
Recommendation for presenting findings from any model to PCA teams

1. Run any model across at least 1 month of Customs data i.e. quite a large representative sample.
2. Make it easy for the PCA team to group transactions that have exceeded the model threshold for anomaly detection by any of/or a combination of the following data elements:
   - For each transaction, calculate the potential revenue foregone which likely requires integration with the tariff. Formula:
     \[
     \text{Declared tax paid} - \text{Predicted tax paid based on new HS code or valuation} = \text{Predicted Revenue foregone}
     \]
3. Tariff preferences, quotas and exemptions need to be taken into account with this calculation. If the value is negative; this may highlight some revenue leakage. Now remove some transactions based on the models classification confidence, and where the revenue foregone is low. Set a de-minimus; SAR 10,000 for example.
4. Feed the resultant set to PCA which are the test of highest quality and highest confidence transactions that you have. Aggregate them by importer or broker and sort from high to low values; so that PCA know exactly who and what to target.
5. When aggregating data; use name similarity models to group names of the same company that are described in many different ways. This is common for exporters names, which are commonly free-text fields and not validated against a local Tax Identification Number or similar. This aligns with recommendation to canonicalize entity names.
Adapt – Obtaining actionable feedback from Customs to improve models

Customs officer or PCA analyst feedback needs to be codified so that it’s easy to interpret and analyze

NOTE: Recommendations provided require availability of active software engineering development teams

Relevance of feedback codification

• Measures the likelihood that Customs are completing the requested task in accordance to standards
• Defines if models are able to identify the expected risks:
  • E.g. Is a misclassification rule identifying misclassification cases, or misdescription of goods cases?
• Identifies the predictive power (“hit rate”) and assess the outcomes compared to random selections
• Provides a view on the items being identified/ reassessed and compares to the outcomes of the model
• Identifies which indicators are more / less effective at identifying risks
• Enables dynamic calibration of models based on findings. E.g.
  • Adjusts the thresholds lower for effective indicators, and higher for less effective indicators

Recommendations

• Reform the PCA reporting business process so that inspectors select from a list of codified options when describing what they found, and what they did next; and the declared items that were involved in the finding.
• The key to a Customs inspection report is to identify the following:
  • What issues did the officer find?
  • Which declared items do the findings relate to?
  • What subsequent actions were taken?
Adapt – Obtaining actionable feedback from Customs to improve models

Example of an effective PCA or Customs Inspection feedback reporting form

NOTE: Recommendations provided require availability of active software engineering development teams

Post-arrival risk assessment report - Findings

- Captures both revenue risks & health, safety and security risks in different sections of the form.
- Once inspection results have been captured and codified; they can be analyzed against the risk indicators that triggered the inspection.
- Cases where a customs officer inspected the cargo and found nothing are also important.

This form section captures the findings, and the items in which the findings relate to. Note; that all findings are codified to simplify the analytics.
Adapt – Obtaining actionable feedback from Customs to improve models

Monitoring “Time Release” is fundamental to avoid misleading feedback from Customs teams, which can damage model predicting power

NOTE: Recommendations provided require availability of active software engineering development teams

Challenge

• One common issue when business process reform is being institutionalised is that officers continue performing the previous process, but make it look like they are following the new process.

• If poor quality or misleading feedback is received by the Advanced Analytics team; it will negate the efforts made, and potentially result in delayed or stalled progress.

Recommendation: inspection Time Release analytics

• Measure the time from when the inspection was assigned to an officer to the time in which the inspection was completed. If the times are short; assume the inspector ‘clicked-through’ the task on their worklist.

• Also possible to correlate inspection times with findings and officer ID’s to determine the most and least efficient inspections at a checkpoint. This needs to be measured over 4-6 months to negate variations in workload over time.

• Major benefits to other parts of the organisation; particularly with respect to efficient job scheduling, performance management, and streamlining the inspection process to promote trade facilitation.
Challenge

As models are deployed in production, and their effectiveness becomes evident; the Advanced Analytics team need to be prepared to defend their methodologies.

Currently, the setting of threshold/cut-off points in models to determine whether a transaction is acceptable or unacceptable is somewhat arbitrary (estimated by the model developer). This approach makes sense, but is not defendable if disputed.

Additionally, our experience often finds that predictive model confidences can be pessimistic, i.e. the model is actually better than the confidence measure suggests.

Recommendation

‘Dynamic scoring’ or ‘dynamic thresholding’: once inspection data has been collected, the team can develop some mathematical models to determine if thresholds should be changed based on real-life inspection outcomes.

Needs to be performed in a very granular way depending on the model. i.e.

- For classification; dynamic thresholds would be calculated for each Tariff Code.
- For Valuation; thresholds are calculated for each canonical goods description; of which there will be millions.

These dynamic thresholding models are resource intensive; so we recommend that they are run as a nightly batch process. Tuning thresholding models occurs gradually over an approximately 6-month period.

Example of where thresholds need to be set for an undervaluation model. Identical challenges exist for all other models.

NOTE: Recommendations provided require availability of active software engineering development teams.

Determining precisely where the threshold between poor data, undervaluation, acceptable valuation, and overvaluation needs a more rigorous scientific approach.
### New recommended potential Machine Learning models

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<table>
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<tr>
<th>Step</th>
<th>#</th>
<th>Model</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collect</td>
<td>1</td>
<td><strong>Sanctioned companies</strong></td>
<td>Identify sanctioned companies based on global watchlists</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td><strong>Container Status Messaging</strong></td>
<td>Use Container Status Messages to identify irregular movements in the supply chain</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td><strong>Country of Origin</strong></td>
<td>Use Global aggregated trade data or similar to identify shipments from an irregular country of origin</td>
</tr>
<tr>
<td>Analyze</td>
<td>4</td>
<td><strong>Business process timing review</strong> (e.g. audits)</td>
<td>Use the 4&lt;sup&gt;th&lt;/sup&gt; dimension – time – to determine if business processes are being implemented according to standard practice</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td><strong>Valuation using External reference data</strong></td>
<td>Develop commodity specific valuation models using external reference data where possible</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td><strong>Exemptions</strong></td>
<td>Use SITC and BEC analysis to identify potential misuse of exemptions</td>
</tr>
<tr>
<td>Act</td>
<td>7</td>
<td><strong>Transactional Scorecard</strong></td>
<td>Develop ensemble models/ transactional scorecards so that Customs officers or PCA analysis can focus on the transactions that are truly of highest risk</td>
</tr>
</tbody>
</table>

Note: Development already kicked off
Identify sanctioned companies based on global watchlists

Concept and background
Learning about the companies and people that are trading with your economy is one of the most important aspects of Customs risk management. There are many company and individual sanctions lists that are maintained by bodies such as the United Nations, USA OFAC, European Commission and others. These lists can complement and enhance existing lists of suspicious or problematic companies that Customs Administrations currently maintain.

Suggested Approach
Free third-party applications such as ‘watchman’, ‘openownership’ and ‘opensanctions’ can offer API’s that you deploy on-premise; or cloud-based that can be integrated with a standard risk assessment data pipeline.

Integration and common challenges
Integration and near real-time assessment of sanctioned entities is very important. A sanctioned company model is less useful for post clearance audit; as the transaction has already occurred. The team must provide sanctioned entity results to Customs officers such that they can
i) Check that the name match is worthy of further review
ii) The confidence in the name match is high
iii) The precise details of the reason for the sanction are shown, as they may not be relevant in certain circumstances.

Use ‘derived’ / cleaned data to pattern match against sanctions lists
Ensure the correct entity type (individual/ company/ vessel/ aircraft) is returned by the API
Remove hit duplication across sanctions lists
**Concept and background**
Traders may obscure a commodities country of origin to reduce duty payable by means of preferences. Training a model based on historical data would be a mistake in this case, as trader behaviour is already established, and the model will simply see these fraudulent shipments as normal trade.

**Suggested Approach**
Recommend using UN Comtrade data or similar global trade repository to develop a comprehensive list of all global commodities exported by country of origin. This can be compared against incoming shipments at HS6 level to determine if the commodities country of origin is statistically likely to be true or false.

**Key Risk Indicators of interest**
- Predicted Country of Origin based on commodity code
- Compared with country of origin
- Identify revenue foregone based on relative tax rules and tariff preference(s)
- Compare with container status messages to identify any rule correlation
Real-time ‘time release’ analytics

NOTE: Recommendations provided require availability of active software engineering development teams

Concept and background
A key role of Customs is to balance the competing interests of revenue collection, managing health, safety and security threats, and facilitating low-risk trade. Improvements in risk management approaches should significantly improve release times, as officers only focus on cargo that is truly of highest risk. This needs to be measured, so that management can confirm that the necessary business processes to facilitate low risk trade are being implemented at the checkpoints by all officers.

Suggested Approach
Use advanced analytics models to track business process timestamps in the Customs Declaration processing system and other related systems to measure; in aggregate; how long it typically takes for key business processes to complete. Analysis of these statistics can identify areas requiring business process reform; or where potential threats are not being managed appropriately. This is also a useful tool for an Internal Audit team; if required.

Key Risk Indicators of interest
• How long does it take to clear high/low risk shipments by checkpoint, officers, importer, types of goods etc.
• How long is each inspection type taking? Are inspections being completed too quickly based on the business process to be followed?
• Which importers are slow to collect their goods from the Customs controlled area?
• Are Customs officers meeting agreed service levels; including for courier shipments or similar?
Valuation of commodities model using external reference data

NOTE: Recommendations provided require availability of active software engineering development teams

Concept and background
Common methods of developing a valuation database utilise an approach that is contrary to the WTO valuation agreement; for whom all APEC members are signatories. Current approach cannot differentiate goods based on their precise brand/category or quality. For many tariff codes there are a wide variety and price range of goods within one code. As discussed earlier; a high quality goods description; if analysed; can differentiate goods based on brand and quality; however training using historical data has in-built biases that will make the results inaccurate over time.

Suggested Approach
Build commodity specific models using external reference data where possible. Examples could include vehicles (new and used), steel rods, wheat, rice, fertiliser, cigarettes and tobacco etc. Global commodity prices, and commodity prices by country of origin can be found online and embedded into models. Develop web screen-scraping tools to automatically keep the data up-to-date. FOB values should be sources; and typical insurance and freight costs added by the model based on source and destination ports.

Key Risk Indicators of interest
- Valuation of goods based on accurate description, country of origin and regularly updated reference data
- Determination of revenue foregone based on tax paid – tax predicted due to new valuation
- Aggregate by exporter/importer/agent and commodity type to identify systemic patterns and abuse; for which dedicated risk rules can be developed.

Japanese car declared from 4 different countries of origin and using 3 different tariff codes.

PCA team highlighting the set of undervalued cars to develop site audit plan.
Develop transactional scorecards so that high risk trade can be checked; whilst rapidly facilitating low risk trade (1/2)

Concept and background
As models are statistical/probabilistic in nature; they will never be 100% accurate in all cases. Therefore, when looking at risk; it’s not one model or indicator that’s important; it’s the combination and frequency of rule hits and model hits that help determine the riskiest transactions that are worthy of more thorough investigation. It’s worth noting that the goal here should not be to inspect everything; as it’s not possible; more to focus inspection resources time on transactions that will yield the most benefit in terms of revenue or ‘security’ threats.

Suggested Approach
Develop ensemble models that combine various models together. Thresholding transactional scorecard models using inspection results becomes critical important. The feedback loop (adapt) needs to be in-place and operational before models of this types should be considered.

Key Risk Indicators of interest
• All risks combined
• Highlight the trade that is truly of highest risk for further scrutiny or inspection
• Facilitate low risk trade

NOTE: Recommendations provided require availability of active software engineering development teams
Act – Deliver transactional scorecards to stakeholders for immediate action

Develop transactional scorecards so that high risk trade can be checked; whilst rapidly facilitating low risk trade (2/2)

NOTE: Recommendations provided require availability of active software engineering development teams
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