Objective

To develop a framework that assess the impact of policy and investment changes related to cargo movement on the container transport chain.
Agenda

• Background
• Case Study - Jordan
• Methodology
• Conceptual Model
• Simulation Framework
• Simulation Outputs
• Conclusion
• Questions & Comments
Global Trade

90% By sea

60% By container

Source: WTO, 2017
Source: IMO, 2017
Source: Statista, 2017

Background
Case Study - Jordan
Methodology
Conceptual Model
Simulation Framework
Simulation Output
Conclusion
Container Movement – Interactions & Complexities

**Port Terminal**
- Background

**Customs**
- Case Study - Jordan

**Ship Agent**
- Methodology

**Flight Forwarder**
- Conceptual Model

**Trucker**
- Simulation Framework

**Customers**
- Simulation Output

**Conclusion**
- Conclusion

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Industry Trends

Mega ship: Fast Operation Needed

Vertical Integration: Hinterland Investments

Technology: Blockchain
Jordan’s Containerized Trade

- 75% of containerized trade are imports
- 45% growth between 2008 to 2016
- 95% throughput growth rate in 10 years
LPI Comparison

<table>
<thead>
<tr>
<th>Country</th>
<th>LPI Rank</th>
<th>Annual TEU Throughput Volume</th>
<th>Container Import Lead Time in Days</th>
</tr>
</thead>
<tbody>
<tr>
<td>USA</td>
<td>10</td>
<td>48.4 million</td>
<td>3</td>
</tr>
<tr>
<td>Germany</td>
<td>55</td>
<td>19.4 million</td>
<td>3</td>
</tr>
<tr>
<td>Brazil</td>
<td>27</td>
<td>9.3 million</td>
<td>4</td>
</tr>
<tr>
<td>Jordan</td>
<td>67</td>
<td>777.5 thousand</td>
<td>9</td>
</tr>
<tr>
<td>China</td>
<td>1</td>
<td>199.6 million</td>
<td>5</td>
</tr>
</tbody>
</table>

Sources: Logistics Performance Index 2016, World Bank, UNCTAD
Expected Initiatives

• ADC plans to reduce container dwell time to 3 days in the coming years, by improving documentation processing time.

• Establishment of a Dry Port to be located close to the capital Amman.

Question:

How effective would these strategies be on the overall container transport chain?
System Dynamics

• A methodology for studying and managing complex feedback systems.

• Identifies the underlying structure of a system to gain insights into behaviors, focusing on the interactions between components of a system.

• Allows decision makers to design policies that seek to eliminate unwanted patterns of behavior.
Procedure

Process Mapping
- Identify Stakeholders
- Conduct Interviews
- Map the Process

Conceptual Model
- Identify Relations
- Develop Causal Loop Diagram

Simulation Model
- Data Collection & Processing
- Develop Stock & Flow Model

Model Testing & Review
- Identify Alternatives
- Compare Output
- Scenario Analysis

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The Import Process

- Aqaba Container Terminal
  - Container discharge (0 day)
  - Customs & Doc Formality (7-8 days)
- Aqaba Customs Inspection Yard
  - Inspection (1 day(s))
  - Gate In (1-2 day(s))
  - Empty Return (1-2 day(s))
- Yard 1
- Yard 2
- Staging Yard
- Importer Facility

Background | Case Study - Jordan | Methodology | Conceptual Model | Simulation Framework | Simulation Output | Conclusion
Assumptions

One size and type of containers

One size and type of trailers

Third order delay assumed in documentation processing

Terminal productivity is at 100%, unless yard gets fully congested

Empty containers for export bookings are picked up from container depots

Vessel load capacity = discharged containers
Stock & Flow Model

Import Container Movement

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Stock & Flow Model

Quayside Sub-System
Stock & Flow Model

Documentation Processing

- Average Containers per Document
- Documents to Process
- Processed Documents
- Maximum Daily Documents

Avg. Documentation Processing Time

Processing Documents

Doc Processing Order N

Simulation Framework

Simulation Output

Conclusion
Stock & Flow Model

Export Container Movement

- Export Orders
- Booked MTY Containers
- Fulfilled Exports
- Pre-Carriage Transit Time

Full Export Bookings
- Available Trailers
- Standard Deviation of Daily Exports
- Average Daily Exports
- Export Booking

Background | Case Study - Jordan | Methodology | Conceptual Model | Simulation Framework | Simulation Output | Conclusion
--- | --- | --- | --- | --- | --- | ---
Stock & Flow Model

Containers in the Terminal Yard

Terminal Capacity

Container Acceptance

<Import Containers in Terminal Yard>

<Export Containers in Terminal Yard>

<Containers Ready for Pick-up>
Stock & Flow Model

Booked Trailers

National Fleet Size

Available Trailers

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Stock & Flow Model

- **Overside Sub-System**
- **Documentation Processing**
- **Import Container Movement**
- **Export Container Movement**

**Background**

**Case Study - Jordan**

**Methodology**

**Conceptual Model**

**Simulation Framework**

**Simulation Output**

**Conclusion**

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## Status Quo (Current) – Inputs

<table>
<thead>
<tr>
<th>Variables</th>
<th>Inputs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily Ships Arrival</td>
<td>1 Ship</td>
</tr>
<tr>
<td>Containers per Ship</td>
<td>1375 Containers</td>
</tr>
<tr>
<td>Inspection Requests</td>
<td>30%</td>
</tr>
<tr>
<td>Containers per Document</td>
<td>1 Container</td>
</tr>
<tr>
<td>Documentation Processing Time</td>
<td>5 days</td>
</tr>
<tr>
<td>Max Daily Documents Processed</td>
<td>700 Documents</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Variables</th>
<th>Inputs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Desired Stock of MTY at Depots</td>
<td>500 Containers</td>
</tr>
<tr>
<td>Avg. Daily Exports</td>
<td>220 Containers</td>
</tr>
<tr>
<td>Standard Deviation of Exports</td>
<td>50 Containers</td>
</tr>
<tr>
<td>Fleet Size</td>
<td>4,000 Trailers</td>
</tr>
<tr>
<td>Terminal Capacity</td>
<td>40,000 Containers</td>
</tr>
<tr>
<td>Open Dry Port</td>
<td>0 (Binary Variable)</td>
</tr>
</tbody>
</table>
Alternative Inputs

Alternative 1: Dry Port Move
Open Dry Port = 1

Alternative 2: Tech Investment
Documentation Processing Time = 3 days

Alternative 3: Combo 1+2
Open Dry Port = 1
Documentation Processing Time = 3 days
Scenarios

Scenario 1: Limited Terminal Capacity
Terminal Capacity = 1,000 Containers

Scenario 2: Limited Fleet Size
Fleet Size = 500 Trailers

Scenario 3: Limitation in Daily Processed Documents
Maximum Daily Documents = 150 Documents
Assessment Criteria

Time Line: 30-days | One Ship Arrival| 1,375 Containers

KPIs:
1. Container Turnaround
2. Delivery Time
3. Trailers Turnaround
4. Container Acceptance (for Scenario 1)
Simulation Output – Base Scenario

Insights:

- **Dry port** reduces the dwell time, but not the container delivery time or container turnaround.
- **Tech** reduces the delivery time and container turnaround compared to **Dry port**.
- **Combo** achieved the highest rank.

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Scenario 1 – Limited Terminal Capacity

Insights:
• The Current and alternative Tech rejected some containers due to space.
• Alternative Dry Port and Combo were able to accommodate more containers.
• Alternative Combo achieved highest rank.
**Scenario 2 – Limited Fleet Size**

**Insights:**
- The dry port alternatives, **Dry Port** and **Combo** had a greater utilization of trucks, which resulted in a higher container turnaround time.
- **Tech** achieved highest rank.
Scenario 3 – Limitation in Daily Documents

Insights:
• Tech and Combo achieved fastest container turnaround times, and delivery times.
• Current and Combo had the highest fleet utilization.
• Combo achieved highest rank.
Simulation Output Rankings

- Current
- Dry Port
- Tech
- Combo

Legend:
- Base
- Limited Terminal Capacity
- Limited Fleet Size
- Limitation in Daily Documents

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Simulation Output – 365 Days

Insights:
- Alternative **Combo** only outperformed the current for 275 days.
- Due to the high fleet utilization, **Combo** caused a massive congestion in the terminal.
- Alternative **Combo+** outperforms the **Current** case over the 365 day period.
Simulation Insights

• Dwell time as a KPI metric is short sighted.

• Short term vs. long term simulation runs provide different insights.

• When selecting a strategy, must consider impact on the other sub-systems and how that impact will affect desired outcome.

• Taking the impact of a strategy on the transport chain, as a whole, will benefit the overall system – making it more competitive.
Model’s Contribution

• Provides a holistic view when assessing strategies.

• Encourages collaboration between different stakeholders.

• Support decision makers in selecting the decisions the will improve the overall container transport chain.

• Evaluate the current container transport chain under different scenarios.
Moving Forward

• Run the model with real-data and create a goodness of fit.

• Relax certain assumptions, to gain additional insights.

• Have model factor in costs.

• Create a web-base easy to use interface for decision makers.
Web-Base Interface

Beyond the Seaport:

The Container Transport Chain

The model allows users to assess the impact of different strategies relating to inland container movement on the container transport chain, under different scenarios. The model is based on Jordan's Container Transport System.

Your Role

You are assuming the role of a policy maker looking to improving the container transport chain, by reducing the delivery time, container turnaround, and adding resilience to the system.

Delivery Time: the time it takes to deliver an import container from the terminal to the final destination.

Container Turnaround: The time from discharging a container in the terminal, to gating it out and delivering it to final destination and returning it back to the terminal.

Resilience: Ability for the transport chain to take on shocks in the system, like demand surges in import, or reduction in transport drivers.

The Team

The model has been developed by Mamoun Toukan and Ho Ling Chan as part of their MASc capstone project at MIT.