

# **A Study of Transportation Disruption Causes and Costs in Containerized Maritime Transportation**

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## Drivers of Supply Chain Vulnerability to Delays

- Just-in-time (JIT) or Lean management approaches
- Globalization
- Centralization of production and distribution
- Outsourcing
- Reduction/Consolidation of the supplier base

(PECK, 2005, CHRISTOPHER, 2005)

## Classification of disruptions and delays by source

Categories	Time	Event	Consequence
<b>Disruption in Supply</b>	March, 2000	A fire in Philips plant	Philips a loss of \$40m, Ericsson \$400m and withdraw from handset market
<b>Disruption in Transportation</b>	September, 2002	West Coast Port lockout	factories were shut down; workers were laid off; sales losses were reported as a result of goods spoilage and out dating
<b>Disruption in Demand</b>	July, 2000	under forecasted	IBM under forecasted its new ThinkPads and had to face back orders and sales loss.
	in 1957	Over forecasted	the new Ford Edsel was estimated to sell about 200000 units, but it sold 63,110 units with discounts



(Sheffi,2005)

**It is very difficult to quantify Supply Chain Disruption costs due to the diversity of sources, supply chains, and lack of data**

# Transportation Delays and Supply Chain Performance

- NOT widely studied in the supply chain literature

## Goals

- To understand the impact of transportation delays on importer and exporter supply chains, supply chain operations, and costs
- To identify companies' delay and disruption management approaches
- To estimate “value of time” in a supply chain context

## Survey Methodology

- A substantial number of pre-interview telephone calls were carried out to collect general company information and to ensure that the interview would be conducted with a manager that had authority
- The data collection process was painstaking and time consuming
  - Importance of support from the Port and Sea Council of New South Wales, Shipping Australia
- Approximately 10% of the phone calls resulted in a successful interview
  - Face to face interviews

## Methodology

- A computer aided personal interview (CAPI) tailored for this research was utilized
  - It ensured a systematic data collection process and the integrity and completeness of the data.
  - Information collected about containerized import or export shipments, delays/disruptions, logistics costs, and transit times.
  - Qualitative data regarding supply chain operations and transport decisions (choice scenarios)

## Geographic Scope and Sample Size

- The data and results presented here are from surveys of importers and exporters located in Sydney, Australia
- A total of 30 managers were interviewed; most interviews lasted, on average, one hour.

## Descriptive Statistics

- Participating companies annual sales ranged from one million to over one billion dollars.
- Annual TEU volumes handled by the managers were also diverse, 60% of respondents reported an annual TEU volume of more than 500 TEU but less than 50,000 TEU.
- The median volume of TEU shipped per year was 2,000.

## Descriptive Statistics

- Equally diverse were the values of containers shipped, ranging from \$6,250 per TEU (grains) to a maximum of \$800,000 per TEU (cosmetics).
- By commodity type, the largest percentage of companies and shipments were related to electrical equipment/products (33% of total), farming and food products (19%), construction products (13%), machines/automotive parts (10%), textile products (10%), consumer products (7%), and mechanical products (4%).

## Descriptive Statistics: disruption costs

- A majority of the respondents (65%) considered that the most important cost is lost sales and related loss of market share or product spoilage (for perishables)
- OTHER:
  - expediting costs (e.g. by using airfreight instead of sea transportation) - increased fees/penalty due to demurrage/storage costs (44%)
  - Increased reporting and administrative costs (30%)
  - Damages to the company's reliability/reputation (22%)
  - Increases in pipeline or in-transit inventory costs (13%).
  - Payment delays and negative impacts on cash flows (9%).

## How they deal with disruptions...

- In the short-term the majority of respondents (78%) indicated that they would change the shipping plan for sea transportation, change freight forwarder or use back up carriers/suppliers.
- Increased communication and information sharing along the supply chain was very important to handle the negative impacts of disruptions (70%).
- In the medium-long term, respondents (52%) indicated that they would increase safety stocks or increase the number of suppliers/sources (60%) if disruptions were considered a significant supply chain problem.

## Methodology II

- Efficient designs minimize the asymptotic variance-covariance matrix, “you get more buck for each choice data”
- Particularly useful for multinomial choice models which have a non-linear log-likelihood function (Rose et al., 2008);
- NGENE, a specialized software for efficient design was utilized to generate the choice situations.

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In the discrete choice scenarios, the attributes associated with a choice are :

**Freight rate --- in USD \$**

**- Surcharge and rebates during disruption scenarios**

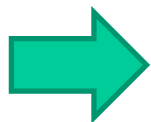
**Transit time --- in days**

**- Additional Delay during disruption scenarios**

**Reliability --- a percentage of on time arrivals**

**Damage rate --- a percentage of the declared cargo value**

**Frequency --- number of sailings per week.**



[Link to product, company, and supply chain data: INTERACTIONS](#)

# Some Survey Results

## Methodology

- Logit model, MNL and Mixed Logit
- Since there are multiple choice situations for each respondent, the estimation must deal with state dependences and serial correlations in the error terms (Morikawa, 1994)
- Results using Limdep-NLOGIT software

## Summary of Willingness to Pay in U\$\$

<b>Attribute</b>	<b>Measurement Units for the Willingness to Pay (WTP)</b>	<b>WTP Normal Operations (1)</b>	<b>WTP With a Disruption (2)</b>	<b>Ratio WTP (2)/(1)</b>
<b>TRANSIT TIME</b>	For a one day reduction	\$33.10	\$180.66	<b>5.46</b>
<b>RELIABILITY</b>	For a 1% increase in on-time deliveries	\$42.17	\$42.81	<b>1.02</b>
<b>DAMAGE</b>	For a 1% reduction in damages	\$197.75	\$383.27	<b>1.94</b>
<b>FREQUENCY</b>	For an additional sailing per week	\$154.31	-	-

# Impacts of Product, Supply Chain, and Company Characteristics

The following dummy variables were added:

- IMP: whether the company acts as an importer or exporter.
- ORSAL: whether the volume of company sales is above or below the average value.
- JIT: whether the company uses JIT procurement.
- RECON: whether the shipment had to be reconsolidated at an intermediary port.
- CIF: whether the shipment used CIF or FOB contractual conditions.
- GDVAL: whether the value of the shipped goods is above or below the average value.
- INDUS\_TYPE: one for each “type” of industry.

# Summary of Willingness to Pay in U\$\$

## with interactions (I)

<b>Attribute</b>	<b>Measurement Units for the Willingness to Pay (WTP)</b>	<b>WTP Normal Operations (1)</b>	<b>WTP With a Disruption (2)</b>	<b>Ratio WTP (2)/(1)</b>
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## Summary of Willingness to Pay in U\$S **with interactions** (II)

Attribute	Measurement Units for the Willingness to Pay (WTP)	WTP Normal Operations (1)	WTP With a Disruption (2)	Ratio WTP (2)/(1)
<b>JIT Reliability</b>	For a 1% increase in on-time deliveries & JIT operations	\$ 22.04	\$ 19.52	<b>0.86</b>
<b>GDVAL Reliability</b>	For a 1% increase in on-time deliveries & High-value products	\$ 32.87		
<b>GDVAL Damage</b>	For a 1% reduction in damages & High-value products	\$ 331.67		
<b>ORSAL Transit Time</b>	For a one day increase & small sales volume	\$ 61.71	\$ 115.53	<b>1.87</b>
<b>RECON Damage</b>	For a 1% reduction in damages with Reconsolidation	\$ 273.40		

# CONCLUSIONS

- Traditional value of time approaches have underestimated the costs of delays and disruptions
- Delays greatly affect the value of time and damage
- Significant impact of Supply Chain (JIT), product (value), and company (sales volume) characteristics

## Future Steps

- Analysis by port/country: we have data from Australia (Sydney), China (Zhenzhen and Shanghai), and the USA (Portland).
- To think about transportation performance measures in a supply chain context

Related paper: “A Survey of China’s Logistics Industry and the Impacts of Transport Delays on Importers and Exporters”

Forthcoming *Transportation Reviews*

*All papers available at:*

[www.cee.pdx.edu/~maf](http://www.cee.pdx.edu/~maf)