Traffic Congestion, Reliability and Logistical Performance
A Multi-sectoral Assessment

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Background

• Institute of Logistics seedcorn research project 1998 on:

  ‘The Impact of Traffic Congestion on Logistics Activity’

• Research updated and extended in 2008 for Joint Transport Research Centre of the OECD and the International Transport Forum

• Vulnerability of distribution operations to congestion-related delays has been affected by a range of logistical / supply chain trends since 1998

• Between 1998 and 2006, traffic on UK roads increased by 10% and congestion significantly worsened:

  8% of road traffic subject to ‘very congested conditions’ (Eddington Report 2006)
Incidence of Traffic Congestion

Levels of Traffic Congestion on the UK Road Network 2004

- Total hours lost per link-km per year
  - 14K - 1.34 million: 5%
  - 28K - 140K: 15%
  - 7K - 28K: 30%
  - 0 - 7K: 50%

Source: Eddington report, 2006

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Worsening Congestion Compressing Iso-chrones

Delivery ranges within 1-5 hours of Maidstone

2005

2007
Methodology

• Literature review: 25 journals + reports since 1998

  Transport KPI surveys

• Analysis of the relationship between the volume of traffic flow and transit time variability for lorries over different distance ranges:

  Highways Agency data
  Vehicle routeing model
  Regression analysis

• Interview survey: 32 senior managers in 24 companies in 9 sectors

  grocery, drinks, steel, construction, paper, chemicals,
  forest products, automotive and electronics

  Visits to distribution centres observe processes
Sensitivity of 13 product groups to transit time variability

<table>
<thead>
<tr>
<th>Product-group</th>
<th>Factor</th>
<th>Rapid depreciation product</th>
<th>Rapid depreciation process</th>
<th>Stock-keeping strategy</th>
<th>Stringent customer service requirements</th>
<th>Supply-chain po</th>
<th>Direct influence end-consumer/agility</th>
<th>Time windows/continuation of disruption in supply chain</th>
<th>Total sensitivity assumed</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Consumer goods slow/fast</td>
<td></td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
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<td>++</td>
</tr>
<tr>
<td>2. Food (fresh)</td>
<td></td>
<td>*</td>
<td>*</td>
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<td>*</td>
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<tr>
<td>3. Clothing</td>
<td></td>
<td>*</td>
<td>*</td>
<td>*</td>
<td></td>
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<tr>
<td>4. Other durable consumer goods</td>
<td></td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
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<td>++</td>
</tr>
<tr>
<td>5. Paper/printed matter</td>
<td></td>
<td>*</td>
<td>*</td>
<td>*</td>
<td></td>
<td></td>
<td>*</td>
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<td>++</td>
</tr>
<tr>
<td>6. Parts/semiminished products</td>
<td></td>
<td>*</td>
<td>*</td>
<td>*</td>
<td></td>
<td></td>
<td>*</td>
<td></td>
<td>+</td>
</tr>
<tr>
<td>7. Instruments/tools/equipment/machinery</td>
<td></td>
<td>*</td>
<td>*</td>
<td>*</td>
<td></td>
<td></td>
<td>*</td>
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<td>+</td>
</tr>
<tr>
<td>8. Car-parts/trucks/cars etc. (automotive)</td>
<td></td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
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<tr>
<td>9. Waste matter</td>
<td></td>
<td>*</td>
<td>*</td>
<td>*</td>
<td></td>
<td></td>
<td>*</td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>10. Building material</td>
<td></td>
<td>*</td>
<td>*</td>
<td>*</td>
<td></td>
<td></td>
<td>*</td>
<td></td>
<td>+</td>
</tr>
<tr>
<td>11. Dangerous goods</td>
<td></td>
<td>*</td>
<td>*</td>
<td>*</td>
<td></td>
<td></td>
<td>*</td>
<td></td>
<td>+</td>
</tr>
<tr>
<td>12. Dry/liquid bulk</td>
<td></td>
<td>*</td>
<td>*</td>
<td>*</td>
<td></td>
<td></td>
<td>*</td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>13. Products sold via internet (b2c)</td>
<td></td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
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</tbody>
</table>

Source: Kuipers & Rozemeijer (2005)
Impact of traffic congestion on freight deliveries

Much traffic congestion is regular and predictable
Build additional slack into delivery schedules to accommodate average delays

Average Weekday Delay to Trucks on UK Trunk Roads

- Morning peak
- Off-peak
- Afternoon peak

Minutes
0 2 4 6 8 10 12 14

Increase fleet size
higher vehicle operating costs

speed-flow curve

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Relationship between traffic volumes and transit time variability

Hourly traffic flow data for 4500 count points on trunk road network

Speed-flow formulae used to convert traffic volume to average speeds
21 lorry route selected from main road freight survey\(^1\) of varying length
100 simulations for each route for randomly generated traffic volumes

\[
y = 1.2638x \\
R^2 = 0.884
\]

\[
y = 1.1081x \\
R^2 = 0.9184
\]

1 Continuing survey of road goods transport

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<table>
<thead>
<tr>
<th>Service Type</th>
<th>Date</th>
<th>Fleets</th>
<th>Artics</th>
<th>Rigids</th>
<th>Total</th>
<th>Trips</th>
<th>Kilometres</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automotive</td>
<td>2001</td>
<td>7</td>
<td>143</td>
<td>50</td>
<td>193</td>
<td>679</td>
<td>179428</td>
</tr>
<tr>
<td>Food</td>
<td>2002</td>
<td>53</td>
<td>1446</td>
<td>546</td>
<td>1992</td>
<td>6068</td>
<td>1454221</td>
</tr>
<tr>
<td>Non-food retailing</td>
<td>2002</td>
<td>26</td>
<td>705</td>
<td>145</td>
<td>850</td>
<td>2496</td>
<td>744087</td>
</tr>
<tr>
<td>Pallet-load networks</td>
<td>2004</td>
<td>17</td>
<td>34</td>
<td>105</td>
<td>139</td>
<td>295</td>
<td>65880</td>
</tr>
<tr>
<td>Next day parcel delivery</td>
<td>2005</td>
<td>12</td>
<td>42</td>
<td>107</td>
<td>149</td>
<td>863</td>
<td>111464</td>
</tr>
<tr>
<td>Building Merchants</td>
<td>2006</td>
<td>35</td>
<td>3</td>
<td>113</td>
<td>116</td>
<td>379</td>
<td>23120</td>
</tr>
<tr>
<td>Food and drink</td>
<td>2007</td>
<td>113</td>
<td>4,696</td>
<td>1,600</td>
<td>6,296</td>
<td>8,000</td>
<td>1,300,000</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td><strong>263</strong></td>
<td><strong>7,069</strong></td>
<td><strong>2,666</strong></td>
<td><strong>9,735</strong></td>
<td><strong>18,780</strong></td>
<td><strong>3,878,200</strong></td>
<td></td>
</tr>
</tbody>
</table>

55,820 journey legs
Relative importance of congestion as cause of delay

55,820 journey legs  26% subject to a delay  35% of delays due mainly to congestion

Source: Transport KPI Surveys  www.freightbestpractice.org.uk
% of total delay time attributable to specific causes

All transport KPI surveys since 2002

Average delay:
Congestion  24 minutes
All causes    41 minutes

Source: Transport KPI Surveys   www.freightbestpractice.org.uk
Factors, other than congestion, affecting reliability

25% of managers interviewed considered congestion the most important source of unreliability

% of unprompted mentions

- Vehicle / equipment breakdowns
- Staffing problems
- Production operations / product availability
- Human error / deficiencies in planning
- Demand fluctuations / poor forecasting
- Delays on other modes
- Access restrictions
- Customer service issues
- Weather
- Delays at delivery points
- Accidents
- Failure by outside carriers

Superimposition of traffic congestion on other sources of unreliability

Complex interaction between various sources of unreliability
### Adaptation of Logistics Systems to Congested Infrastructure

#### Transport

<table>
<thead>
<tr>
<th>Measures</th>
<th>Survey response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increase fleet size</td>
<td></td>
</tr>
<tr>
<td><em>increase in number of powered units (rigids / tractors)</em></td>
<td><em>little / no increase</em></td>
</tr>
<tr>
<td><em>increase in the articulation ratio</em></td>
<td><em>marginal decline</em></td>
</tr>
<tr>
<td>Adjustments to journey planning</td>
<td></td>
</tr>
<tr>
<td><em>reduction in average speed in routing software</em></td>
<td><em>only 9% on companies</em></td>
</tr>
<tr>
<td>Rescheduling deliveries to off-peak</td>
<td></td>
</tr>
<tr>
<td><em>% of truck-kms run between 8pm and 6am: 8.5% (1985) 21% (2005)</em></td>
<td></td>
</tr>
<tr>
<td><em>50% of companies had increased night-time operation over past 5-10 years</em></td>
<td></td>
</tr>
</tbody>
</table>

#### Altering working practices

- *Working time directive: minor constraint on ability to accommodate congestion*

#### Switching transport mode (to rail)

- *several examples*
Adaptation of Logistics Systems to Congested Infrastructure

1998 and 2008 surveys: *almost unanimous agreement that worsening traffic congestion was increasing inventory levels*

Weeks of Inventory in the Manufacturing, Retail and Wholesale Sectors

<table>
<thead>
<tr>
<th></th>
<th>1986</th>
<th>2005</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>7 weeks</td>
<td>4.4 weeks</td>
</tr>
</tbody>
</table>

Source: DfT: Focus on Freight

Average length of haul 140 km
Average journey speed 70 km per hour
Average journey time 2 hours

On 10% most seriously delayed journeys on strategic road network, average delay = 26.6 mins

Effect on in-transit inventory level and total supply chain inventory is negligible

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Warehousing

Warehouse design:

- *Reconfiguring internal layout – esp. for crossdocking*  
  little evidence

- *Separation of inbound and outbound bays*  
  little evidence

Warehouse operating system:

- *Extra slack in the handling systems*  
  none reported

- *More frequent switch from put-away to crossdocking*  
  very limited

- *store- to line-picking*  
  very limited

- *Increased space requirement*  
  very limited

Increase number of warehouses / vehicle out-bases  

some examples

Relocation of warehouses  

none reported
Conclusions

- Traffic congestion responsible for 23% of total delay time in road freight operations in the UK
- Complex relationship between congestion and other sources of unreliability
- Little evidence of congestion inducing logistical restructuring, increased capacity and changes in working practices
- Main impacts: *growth of evening / night-time delivery*
  - greater use of regional depots / outbased vehicles and drivers
  - modal shift to rail
- Gradual increase in traffic congestion has made adaptation easier
- Managers have become skilled in ‘working around’ congestion
- Most congestion is regular and predictable: *probability of major disruptions still quite low though increasing and significantly higher in some regions / corridors.*
- Significant variation in congestion impact within and between sectors
- A few companies are seriously exposed to congestion due to geography, product type, scheduling constraints and customer requirements.
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