Designing and redesigning international manufacturing networks

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Agenda

Designing international manufacturing networks
• At what level should we look?
• How can we map networks at an appropriate level?
• Are there generic network structures?

Redesigning international manufacturing networks
• What happens in a network when plant roles and responsibilities change?
• How does offshoring and backshoring impact the network balance?

Concluding remarks
IMN at the Company level
IMN at the Business Area level

- Business Area 1
- Business Area 2
- Business Area 3
IMN at the Product Group level

Product group 1
PG2
PG3
PG4
PG5
PG6
PG7
IMN for one specific Product Group
Network mapping model – Product Group level
P, SC, D = ...

**Competence Bundles**
- Development (D)
  - Product improvement
  - New product technologies
  - New process technologies
- Supply Chain (SC)
  - Logistics
  - Procurement
  - Supplier development
- Production (P)
  - Production
  - Technical maintenance
  - Process improvement

**Plant Types**

(Source: Feldmann & Olhager, 2013, "Plant roles: Bundles of competences and their relationships with site location factors and performance", *IJOPM*)
Research on Product Group IMN design

- 5 companies
- 20 product groups
- 1-8 plants involved in a product group network
- Plant operations:
  - component plant
  - assembly plant
  - "integrated plant" = component mfg + assembly

## 20 Product Group networks

<table>
<thead>
<tr>
<th></th>
<th>Company 1</th>
<th>Company 2</th>
<th>Company 3</th>
<th>Company 4</th>
<th>Company 5</th>
</tr>
</thead>
<tbody>
<tr>
<td># Networks in study</td>
<td>4</td>
<td>5</td>
<td>4</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td># Plants in networks (range)</td>
<td>3-8</td>
<td>3-6</td>
<td>4-5</td>
<td>1-7</td>
<td>2-3</td>
</tr>
<tr>
<td>Total # plants involved in</td>
<td>13</td>
<td>10</td>
<td>12</td>
<td>11</td>
<td>3</td>
</tr>
<tr>
<td>these networks</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td># Plants in Europe</td>
<td>5</td>
<td>4</td>
<td>6</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td># Plants in Americas</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td># Plants in Asia</td>
<td>6</td>
<td>3</td>
<td>4</td>
<td>3</td>
<td>0</td>
</tr>
</tbody>
</table>

# Data collection

<table>
<thead>
<tr>
<th>Decision category</th>
<th>Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Factory characteristics</td>
<td>Factory role; Site competences and responsibilities (production, supply chain, and development); Capacity; Size; Specialisation; Production process type; Proprietary vs. standard equipment; Automation level</td>
</tr>
<tr>
<td>Geographical dispersion</td>
<td>Location of factories; Links between factories</td>
</tr>
<tr>
<td>Horizontal coordination</td>
<td>Coordination mechanisms between production, purchasing, R&amp;D, and product and process development.</td>
</tr>
<tr>
<td>Vertical coordination</td>
<td>Number of successive stages in the internal network; Make/buy decisions; Location and characteristics of strategic suppliers</td>
</tr>
</tbody>
</table>
Four network types

Assembly plants

One

Many

Component plants

One

Many

Linear

Divergent

Convergent

Mixed

Managerial challenges

<table>
<thead>
<tr>
<th>Assembly plants</th>
<th>One</th>
<th>Many</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>One</strong></td>
<td><strong>Many</strong></td>
<td></td>
</tr>
<tr>
<td>Degree of standardization across sub-networks, Distribution of R&amp;D responsibilities</td>
<td>Location of new assembly factories (for capacity and/or new markets)</td>
<td></td>
</tr>
<tr>
<td>Linear</td>
<td>Divergent</td>
<td></td>
</tr>
<tr>
<td>R&amp;D coordination, Material flow synchronization</td>
<td>Mixed</td>
<td></td>
</tr>
<tr>
<td>Convergent</td>
<td>Mixed</td>
<td></td>
</tr>
</tbody>
</table>

Location of new assembly factories (for capacity and/or new markets)

Balancing the network through expansion, consolidation and relocations

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Concluding remarks
Manufacturing location and relocation

- Proximity to market
- Access to development competences
- Access to low-cost manufacturing
Case example

**Background**: Management of a MNC found it increasingly difficult to supply US customers from Europe

**Action**: Supply US from China, by adding competencies and responsibilities to the China plant

"Sub-network": Small products in the product group

Before ...

After ...
"Sub-network": Large products in the product group

Before ...

1st tier suppliers

Global suppliers

Local suppliers, northern Europe

Local suppliers, China/Asia

1st tier suppliers

Global suppliers

Local suppliers, northern Europe

October products in the product group

Before ...

1st tier suppliers

2nd tier suppliers

Sales companies in South East Asia

Plate package

Sweden 1

Sweden 2

DC Europe

German customers with short lead time demands

Direct sales, Europe and US

Direct sales, China and Japan

Smaller Asian customers

Sales companies in South East Asia

Two plants in one site

Component plant

Assembly plant

After ...

1st tier suppliers

Global suppliers

Local suppliers, northern Europe

Local suppliers, China/Asia

1st tier suppliers

Global suppliers

Local suppliers, northern Europe

October products in the product group

After ...

1st tier suppliers

2nd tier suppliers

Sales companies in South East Asia

Plate package

Sweden 1

Sweden 2

DC Europe

German customers with short lead time demands

Direct sales, Europe

Direct sales, China, Japan and US

Smaller Asian customers
Model for mapping global responsibilities and illustrating plant role changes

So ...

• ... changing the *plant role* of one plant affects the *network balance*
• ... plant role changes cannot be taken in isolation, but are *network decisions*
• ... from the Swedish perspective, the plant role change was a case of *offshoring*
• ... what about *backshoring*?
  – i.e. bring manufacturing back to Sweden
Survey on manufacturing relocation from and to Sweden between 2010-2015

• Data collection: September-October 2015
• Targets: All Swedish plants with more than 50 employees
  • 1637 plants
  • Industry code (SIC) 10-33
• Responses: 373
  • 22.8 % response rate
• Survey design
  • Unit of analysis: the plant
  • 229 items questions per respondent
  • Same set of questions for offshoring and backshoring

[Source: (1) Johansson & Olhager, 2018, Manufacturing relocation through offshoring and backshoring: the case of Sweden, JMTM; (2) Johansson & Olhager, 2018, Comparing offshoring and backshoring: The role of manufacturing site location factors and their impact on post-relocation performance, IJPE, and works in progress]
Key results

• Still more offshoring than backshoring, approximately 1:0.6
  • ”better” ratio in Sweden than in other countries! But still a net outflow!
• All industries off- and backshore
  • Low-tech < Medium-low tech < Medium-high tech & High-tech
• All plant sizes off- and backshore
  • Small plants move less, while large both off- and backshore
• Plants in large networks move more frequently
  • both internally and externally
• Distinctly different drivers for off- and backshoring
  • One driver for offshoring = labour cost
  • Many drivers for backshoring!
To where & From where?

- Offshoring
- Backshoring

Nordic:
Western Europe:
Eastern Europe:
North America:
Latin America:
China:
India:
Rest of Asia:
Rest of World:

-40,0% -30,0% -20,0% -10,0% 0,0% 10,0% 20,0% 30,0% 40,0%
# Relocations and innovations at the focal plant

To what extent are you pursuing manufacturing related innovations?  
(Scale: 1 = Not at all; 2 = Small extent, 3 = Moderate extent; 4 = Large extent; 5 = Very large extent)

<table>
<thead>
<tr>
<th>Type of innovation</th>
<th>Offshorers</th>
<th>Bi-directional movers</th>
<th>Backshorers</th>
<th>Non-movers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N = 82</td>
<td>51</td>
<td>48</td>
<td>192</td>
</tr>
<tr>
<td>Digitalization</td>
<td>2.79&lt;sup&gt;d&lt;/sup&gt;</td>
<td>2.81&lt;sup&gt;e&lt;/sup&gt;</td>
<td>3.28&lt;sup&gt;c,d,e&lt;/sup&gt;</td>
<td>2.82&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>New high-tech materials</td>
<td>2.37</td>
<td>2.56</td>
<td>2.66&lt;sup&gt;c&lt;/sup&gt;</td>
<td>2.27&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>New process technologies</td>
<td>2.55&lt;sup&gt;c,d&lt;/sup&gt;</td>
<td>2.49&lt;sup&gt;b&lt;/sup&gt;</td>
<td>3.09&lt;sup&gt;a,b,d&lt;/sup&gt;</td>
<td>2.21&lt;sup&gt;a,c&lt;/sup&gt;</td>
</tr>
<tr>
<td>Automation &amp; robotization</td>
<td>3.17&lt;sup&gt;c&lt;/sup&gt;</td>
<td>3.23</td>
<td>3.64&lt;sup&gt;c&lt;/sup&gt;</td>
<td>3.31</td>
</tr>
</tbody>
</table>

<sup>a</sup>: difference is significant at the 0.001 level;  
<sup>b</sup>: difference is significant at the 0.01 level;  
<sup>c,d,e</sup>: difference is significant at the 0.05 level.
Concluding remarks

• All practitioners strive for a balanced manufacturing networks!

• Who should be doing what, where, with how much capacity, and for which product group?
  – Who = Rightsourcing
  – What = Component mfg and/or assembly (+R&D)
  – Where = Rightshoring
  – How much capacity = Rightsizing (wrt investments and innovations)

• A change in any of these dimensions affects the balance of the network!

• Thus, all dimensions should be considered simultaneously!