Economics of Facilities Siting and the NIMBY Syndrome: Some Asian Examples

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The Siting Dilemma

Generally, society wants to have NIMBY facilities as they are necessary and beneficial for development and growth.

However, few would be willing to bear the risk and cost of the hosting community.

Examples:
- Sewage treatment plants
- Nuclear power plants
- Airports
- Landfills
- Incinerators
- Hospices
- Columbarium
- Toxic waste dumps
The Siting Dilemma

NIMBY Syndrome: The problem is siting of such facilities and accommodating the local residents.

CBA study: may be biased if based on national accounting stance; host not compensated for negative externality.

Kaldor-Hicks efficiency criteria may be biased.
## Past Examples

<table>
<thead>
<tr>
<th>Project Type</th>
<th>Siting Approach &amp; Resolution Instruments</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pengerang Petrochemical and LNG Terminal, Malaysia (2014)</td>
<td>Requires a 5 kilometres buffer zone. Malaysian government’s resettlement and infrastructure program to create new centres for the villagers. Compensation scheme to the villagers.</td>
<td>Phase 1 of the oil terminal completed and second phrase is due to be completed by 2019</td>
</tr>
<tr>
<td>Nuclear power plant in China: Guangdong province, Daya Bay Nuclear Power Plant (1994)</td>
<td>Population living near the site has been resettled in other areas. Mitigation measures have been undertaken to improve safety of plant.</td>
<td>The plant has been sited successfully. However, it is plagued by minor accidents and there have been reports that traces of nuclear materials have been found in nearby waters.</td>
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## Past Examples

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<td>Chemical plant in Taichung: Bayer Group and Taiwan Government (1998)</td>
<td>Elaborate EIA undertaken and steps taken to ensure that even in the case of an explosion, gas released will be below dangerous levels.</td>
<td>Unsuccessful, partially due to public dissatisfaction over past environmental degradation.</td>
</tr>
<tr>
<td>Airport in Hong Kong: Provincial Airport Authority, Chek Lap Kok Airport (1998)</td>
<td>Resettlement programmes for the affected population. Anti-pollution measures recommended.</td>
<td>Project completed.</td>
</tr>
<tr>
<td>Nursing Home in Singapore: Ministry of Health (2014)</td>
<td>A closed door dialogue session with the Ministry of Health to allow residents to understand the rationale for the need to build a nursing home and gather feedback.</td>
<td>Building is in progress</td>
</tr>
</tbody>
</table>
NIMBYS in Progress

- Plans to build waste incineration power plant in East China's Zhejiang Province, China were halted when violent protest erupted (May 2014)
- Protests in Kuala Lumpur, Malaysia against proposed rare earth refinery (November 2012)
- Taiwanese stage anti-nuclear protests against newly-constructed power plant and nuclear waste storage (March 2014)
- Residents and groups from Balong, Indonesia protest against nuclear power plant at Balong near Mount Muria (March 2014)
- Chinese officials in Maoming, Guangdong province say controversial petrochemical plant will not go ahead if majority of the city’s residents object (April 2014)
Conflict between demands for consumption and growth and demands for higher quality of life

Why conflict now? Changes in the Asian environment

- Rising affluence
- Greater educational opportunities and higher literacy rate
- Wider information dissemination
- Globalization
- Distrust of governments and private corporations
- Demand for energy, expansion of facilities to meet growth
- Health consciousness
Lessons to be learnt:

• Valuable experiences to be learnt from North America and European facilities siting.

• Europe also faces NIMBY problems, in particular siting along territorial borders which can be considered as transboundary NIMBY. E.g. Germany against Poland’s siting of nuclear plants along German borders.

• Public policy research should aim to reduce such intrasocial conflicts by innovating new conflict resolution instruments.

• Comprehensive economic research on cost and benefit analysis of NIMBY Syndrome.
Literature

• Political, Social and Administrative Aspects
  (McDermitt, 1991; Opaluch et al., 1993; Rabe, 1994; Pretts, 1995; Aldrich, 2008; Rudy, 2014)

• Technical and Perception of Risks Management

• Economic Literature
Common Characteristics of NIMBY Facilities

- Public sector involvement
- Non-exclusive externalities in immediate neighbourhood
- Location in remote areas
- Involvement of general public and open forums
- Conflict between outside residents’ demands for a faster response in project location approval and local residents’ opposition
# Classification of NIMBY Facilities

<table>
<thead>
<tr>
<th>High-Hazardous NIMBY Facilities</th>
<th>Mid-Hazardous NIMBY Facilities</th>
<th>Low-hazardous NIMBY Facilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemical plants</td>
<td>Petrol kiosks</td>
<td>Schools</td>
</tr>
<tr>
<td>Refineries</td>
<td>Hospices/hospitals</td>
<td>Golf courses</td>
</tr>
<tr>
<td>Open/strip mines</td>
<td>Highways</td>
<td>Cemeteries/Columbarium</td>
</tr>
<tr>
<td>Toxic waste treatment plants</td>
<td>Industrial parks</td>
<td></td>
</tr>
<tr>
<td>Nuclear power stations</td>
<td>Sewage treatment works</td>
<td></td>
</tr>
<tr>
<td>Nuclear waste disposal</td>
<td>Airports</td>
<td></td>
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<tr>
<td></td>
<td>Landfills</td>
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</tr>
</tbody>
</table>
• Fire broke out at the nuclear power plant in Onagawa, Japan on February 24, 2000. This followed from September 1999 nuclear accident at an uranium processing plant in Tokaimura, Japan. In that accident, an improper amount of condensed uranium was poured into a mixing tank resulting in radiation exposure to more than 440 people near the plant.

• Guiyi, Guangdong province, China, is the largest electronic waste site in the world. The primitive recycling method operations in Guiying is both toxic and dangerous. 80% of the children living in the area suffers from lead poisoning. Discarded electronics lie in pool of toxin that leach into groundwater making water around the area undrinkable.
04 Hazardous NIMBY Facilities

- Chronic shortage of dump sites in Tokyo and other big Japanese cities have led to waste being shipped to and incinerated in surrounding rural communities like the Hinodecho village, west of Tokyo. Ash tainted with dioxin, floated down the valley and is blamed for rising cancer rates (four times the national average) in Hinodecho. Protests to stop the construction of a second dump site there failed. The bureaucrats denied using heavy-handed tactics and claimed that Tokyo expropriated the land for ‘public benefit’. 
Case Studies

05

Negative Externalities
- Many residents are uprooted from their homes
- Moving creates considerable anxiety and disruption
- Residents face trouble of finding new jobs
- Remaining residents living near the dam face disruptions to transportation services, more distant schools and a sense of isolation
- Ecological and environmental worries

Positive Externalities
- Flood prevention
- Water resource
- Energy generation

The benefits of dams are not easily recognized by individuals, resulting in feelings of unfairness amongst host communities.
• Choosing dam sites
  • Rural areas with low population density

• Soft social controls
  • Subsidies (e.g. Water Resource Measures and Water Resource Funds)
  • Cities and prefectures that benefit from the dams pool money to provide funds for the affected citizens and families
  • Established Water Week and Water Day in August to promote importance of water resources
  • Familiarization strategies with other existing host communities
    E.g. Gosho Dam
  • Information tours to show the benefits of dams
  • Government integrated education on the benefits of dams into the school life of children
Case Studies

Japan: Dams Siting

- Hard social controls
- Land expropriation
- Imprisonment of resistance leaders
  - Murohara was sentenced to ten months in prison for leading activists to keep surveyors at bay
- Slashing of funds available to the resistant village
  - Kito and Okutsu village
  - Threats were made to eliminate jobs, financial aid for children was cut without explanation
  - Kito village

- Over time, the Japanese government has reduced the building of dams and improved soft social controls such as Water Resources Funds.
Case Studies

Indonesia: Nuclear power plant siting

- Negative Externalities
  - Potential liability costs
  - Environmental regulation costs
  - Higher consumer taxes due to developing and maintaining the nuclear power plant
  - Costs associated with potential nuclear accidents since Indonesia lies on the Pacific Ring of Fire with high geological activity such as earthquake and volcano
  - Cost of nuclear waste is being transferred to future generations
  - Trans-boundary effect during nuclear accident

- Positive Externalities
  - More job openings and creation
  - Reduces energy price level
  - Reduce greenhouse emission of the coal-fired electricity plants
05

Case Studies

Indonesia: Nuclear power plant siting

- Soft social control
  - Lower electrical bills for the communities in the vicinity of the nuclear power plant
  - Established safety measures to be utilized in case of accidents
  - Defuse worries about major accidents
  - Citation ceremony and publicity for local community hosts
  - Set up Nuclear Energy Regulatory Agency, Badan Pengawas Tenga Nuklir for regulations, licensing processes and inspections.
- Hazardous facilities require different strategies
Indonesia: Nuclear power plant siting

- Tools of expropriation and police violence not used
- Anti-nuclear groups and civil society were large and well-organized
- Widespread, well-informed and long-term resistance, rally and demonstrations
- Act in accordance with International Atomic Energy Agency standard and supervision but lack a comprehensive and transparent analysis of the risks associated with the plan
- Nuclear crisis in Fukushima, Japan served as a warning of the effect of nuclear power and to increase the quality of nuclear safety
- Corruption and regulatory risks becomes a nuclear security and safety threat
**Case Studies**

**China: Waste Incinerator**

- **Negative Externalities**
  - Burning trash releases toxin into the air affecting the health of residents living in the vicinity
  - Residents have to endure the smell from the waste being transported to the incinerator
  - Environmental problem due to release of toxin and dangerous substance that would potentially cause global climate change.

- **Positive Externalities**
  - Energy recovery from burning of waste such as heat energy can be converted to other uses
  - Reduce landfills for waste
China: Waste Incinerator

• Hard social controls
  • Public security enforcement to force protestors to remain in orderly behavior as many were injured during the clash with police
  • Affected residents feel that government did not inform or discuss with them the plans to construct the waste incinerator and no environment assessment was conducted.
• Chinese government suspend plans to build the waste incinerator due to violent clashes with police and public officers.

Case Studies
Singapore: Columbarium Siting

Met with strong opposition from residents due to cultural and traditional beliefs

- **Negative Externalities:**
  - Reduce Property Prices
  - Traffic jam during religious festivals
  - Pollution from incense paper and offering

- **Soft social controls**
  - Ensure no pollution from the burning of incense
  - Traffic management during festive period
Considered non-hazardous and posed no danger to the residents around the neighbourhood

• Negative externalities:
  • Fall in property prices
  • Loss of public spaces such as recreational area

• Positive externalities:
  • Reduce travelling time for family members since it’s sited in a relatively central area in Singapore
  • Soft social controls
    • Public facilities such as pavilion and walking shelters are built
    • Increase chance of balloting for existing elderly residents for the elderly studio apartment
  • Dialogue with residents in the neighbourhood
Existing Conflict-Resolution Instruments

1. Local regulations and zoning
2. Public hearing and Environment Impact Assessment
3. Licenses and Permits
4. Mitigation policies
5. General compensation for immediate local residents
6. Compulsory acquisition of land with market compensation
Existing Conflict-Resolution Instruments

- Compulsory acquisition of land with market compensation

- Before the land was compulsorily acquired, the landowner enjoyed $U_2$ level of welfare (0X property services, 0M level of money income on wealth).
- Property owned by landowner has a market price given by the slope of line $P_1P_2$.
- If landowner sells the land, he would end up enjoying a lower welfare, $U_1$ (0 property services, $O P_1$ level of money income).
- If the basis for compensation for compulsory acquisition of land is that of market value, the loss in welfare ($U_2 - U_1$) may occur.
- One could also argue that with compensation $MP_1$, the landowner could now purchase a cheaper property and be better off (budget line $P_1P_3$ and utility $U_3$).
- Landowner would have done so earlier by selling his present property for $MP_1$, and using the monetary resources to buy cheaper property.
CBA and Compensation Efficiency

1. No compensation claim should be allowed if congestion has not yet set in.
2. Compensation should be paid only where impacts create real costs and not in cases where they involve a transfer of income or wealth.
3. Compensation scheme should require the project developer to pay for harmful effects arising from the facility, but it should also allow the owner of the facility to receive payment for beneficial impacts.
4. Compensation claims should be based on significant external impacts.
5. Double counting of project impacts should be avoided.
Sealed-bid Auction Mechanisms

• Analysis for economic bads.

• Social cost to ith community for hosting facility
  = \( c_i > 0 \) \hspace{1cm} (i = 1, 2, \ldots, n)

• How should ith community make its bid \( b_i \)?

• If ith community ‘wins’, it earns Surplus = \( b_i - c_i \)

• Assume that all bidders’ valuations are independent and identically distributed and \( F \) denotes the probability distribution function of the valuations.

• Probability of ith community winning with bid
  = \( [1-F( B^{-1} (b_i))]^{n-1} \)
Sealed-bid Auction Mechanisms

- If the community does not win the bid $b_i$, it pays an amount $\theta b_i$, where $0 \leq \theta \leq 1$.
- Community will decide on the bid to maximize expected surplus $\tau_i$.

$$\tau_i = (b_i - c_i)[1 - F(B - 1(b_i))]^{n-1} - \theta b_i[1 - \{1 - F(B - 1(b_i))\}^{n-1}]$$

- Community $i$ chooses the bid $b_i$ such that:
  $$\frac{\partial \tau_i}{\partial b_i} = 0$$

- Community $i$ chooses the bid $b_i$ such that:
  $$\frac{\partial \tau_i}{\partial b_i} = 0$$
Eventually,

\[ B(c_i) = b_i = \frac{1}{(1+\theta)}[c_i + \frac{\int_{c_i}^{\infty} [1-F(y)]^n - 1 \, dy}{[1-F(c_i)]^n - 1}] \]

If there is no penalty payment (i.e. \( \theta = 0 \)), the bid is optimal.
If there is penalty payment imposed on the non-host communities, and in the real world situation where their social costs are finite and close to one another, the solution is a first approximation.
The bidding function is dependent on \( \theta \), \( c_i \) and \( n \).
3 Schemes

Scheme 1 (à la Kunrenther’s model)

1. Lowest bid wins.
2. Loser does not pay any penalty. $\theta = 0$

\[ b_i(1)^* = c_i + \frac{\int_{c_i}^{\infty} [1 - F(y)]^n - 1 \, dy}{[1 - F(c_i)]^n - 1} > c_i \]

3. Winning bidder will always receive a net gain from hosting the facility.
4. The community can bid high with no adverse consequences of doing so, thus this model is unable to solicit truthful bidding from the communities.

- Communities consciously bid high to increase their likelihood of not hosting the NIMBY facility, or to gain from compensation.
3 Schemes

Scheme 2 (Quah and Tan, $\theta = 1$)

1. Lowest bid wins.
2. Loser pays a penalty equal to its bid amount.
   \[ \theta = 1 \]
3. Winner gets compensation equals to its bid amount.
   - The ‘optimal’ bid in scheme 2 is equal to half the ‘optimal’ bid in scheme 1
     \[ b_i(2)^* = 0.5b_i(1)^* \]
   - If instead $\theta = 0.5$, then it follows that the ‘optimal’ bid is equal to $2/3$ of the ‘optimal’ bid in scheme 1
   - Prevents communities from purposely bidding many times higher than their true social cost.
3 Schemes

Scheme 3 (Quah and Tan, $\theta = 1/(n-1)$)

1. Lowest bid wins.
2. Loser pays a penalty equals to $1/(n-1)$ of its bid amount.
   $\theta = 1/(n-1)$
3. Winner gets compensated its bid amount.
   • Similar to scheme of Kunreuther and Kleindorfor (1986): if community $i$ is not selected to host the facility, then that community will have to pay a tax of $b_i/(n-1)$ to help compensate the hosting community.

$$b_i^{(3)*} = \frac{n-1}{n} \left[ c_i + \int_{c_i}^{\infty} \frac{[1-F(y)]^{n-1}}{[1-F(c_i)]^{n-1}} \, dy \right]$$
Sealed-bid Auction
Mechanisms: Discussions

- Schemes 1, 2, and 3 provide some means of assessing the actual and perceived externalities from NIMBY facilities, and ensure that the optimal location is selected in terms of minimizing social cost.
- In schemes 2 and 3, the sum of payments from the non-host communities will exceed the bid put in by the winner.
  - Excess money could be put into a special fund
    - Further compensate the host community.
    - For contingencies or other matters pertaining to the externalities imposed by the NIMBY facility.
- Scheme 1 induces strategic bidding, where communities bid high (more than their true social cost) to avoid hosting the NIMBY facility, or hoping to gain from compensation.
- Schemes 2 and 3 restrain such behaviors.
Other Compensation
Auction Methods

- Voluntary auctions for noxious facilities (O’Sullivan, 1993)
- Including public preferences in current citing mechanisms (Opaluch et al., 1993)
- Siting lottery with victim compensation (Sullivan, 1992)
- Trade mechanism (Course and Kim, 1997)
# Major Siting Approaches and Subsets

Compensation auction mechanisms require:

<table>
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<tr>
<th>Environmental Suitability</th>
<th>Social Equity</th>
<th>Community Control</th>
</tr>
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<tbody>
<tr>
<td>Constraint minimization</td>
<td>Fairness: distribution of facilities</td>
<td>Location control</td>
</tr>
<tr>
<td>• Area screening/identification</td>
<td>• Unfair locations</td>
<td>• Voluntary communities/local veto</td>
</tr>
<tr>
<td>• Site screening/identification</td>
<td>• Fair locations</td>
<td>• Voluntary site vicinity</td>
</tr>
<tr>
<td>• Site comparison</td>
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<td>• Voluntary access routes</td>
</tr>
<tr>
<td>Opportunity maximization</td>
<td>Fairness: distribution of costs and benefits</td>
<td>Procedural control</td>
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<tr>
<td>• Compatible land uses</td>
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<td>• Use of third parties</td>
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<tr>
<td>Service maximization</td>
<td>Procedural fairness</td>
<td>Facility control</td>
</tr>
<tr>
<td>• Service to facility</td>
<td>• Conflict resolution/consensus building</td>
<td>• Facility characteristics</td>
</tr>
<tr>
<td>• Service from facility</td>
<td>• Community involvement</td>
<td>• Facility management</td>
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Implementation and the Various Decision Stages

1. Proposal
2. Environmental Impact Assessment and Benefit-Cost Analysis
3. Mitigation and compensation
4. Public and stakeholders participation
5. Compensation Auction Mechanisms
6. Further negotiations and results
Conclusion

• Basic problem of siting: asymmetric distribution of costs and benefits among potential stakeholders
• Increasing concerns over NIMBY facilities in Asia
• Need for a more efficient and less time-delaying conflict resolution instruments
• Sealed-bid non-collusion auction mechanism
• Penalty should be imposed on non-successful potential hosting communities
• When number of potential host communities increases, bids will converge to their true social costs
Conclusion

• Sealed-bid auction mechanism is but one stage in five stages of the multi-criteria siting process.
• For NIMBY facilities that involve threats to health and human life, mitigation attempts and increased engagement with local public might be more productive.
• Bribe effect (Frey et al., 1996)
• Besides economic efficiency and equity considerations, other measures of evaluation for siting NIMBY facilities include dominant strategy implementation, incentive compatibility, budget balancing, individual rationality.
• Transboundary NIMBYS and sovereignty issue could be a topic of future research
See earlier works
