EMPERICAL INVESTIGATION OF ENERGY POVERTY IN JAPAN – A CATEGORICAL COMPARISON OF HOUSEHOLDS

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1st IAEE Online Conference
Concurrent Session 9: Energy Poverty
Parallel Room 9
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• Literature Review + Research Question & Focus
• Methodology (Original Survey)
• Results
• Conclusion
Introduction – World Energy Status

• Energy is a daily necessity all across the globe
• Between 1990 – 2014, world economy nearly doubled while energy consumption increased 58.9% [1]
• Energy Consumption expected to increase by 50% between 2018 – 2050. [2]
• Studies have shown causal relationship between energy consumption and economic growth [3]

[1] Le et al., 2020
[2] EIA, 2019
[3] Rathnayaka et al., 2018
Introduction – World Energy Status

• Still nearly 940 million people (13% of global population) have no access to electricity. [4]

• Imbalance of energy consumption and economic prosperity across world

• Global intermittency in energy costs

• Climate change and GHG emissions

• Introducing renewables → costs rise in long term [5][6]

[4] Ritchie et al., 2019
[5] Chapman et al., 2019
• Energy poverty (EP): Inability to possess/afford modern energy services
• Developing countries and developed countries
• Scope of this study is Japan
# Literature Review – Case of Japan

## Japan: 2016~ vs. Europe: 1970s~

<table>
<thead>
<tr>
<th>#</th>
<th>Author</th>
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Introduction  Literature Review  Methods  Results  Conclusion
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Introduction | Literature Review | Methods | Results | Conclusion

Japan: 2016~ vs. Europe: 1970s~
Literature Review

• Majority of studies are based on NSFIE survey, without focusing on standards and qualitative data

• Studies focused on parents, aged etc.

• No study of college students, while studies elsewhere prove them to be vulnerable to EP [16] [17]

• It is required to assess college students vs. ordinary households in Japan

[16] Morris et al. 2018
[17] Ntouros et al., 2019

Original Surveys conducted
Research Questions

• (1) Is EP an existing issue in Japan? If so, to what extent?

• (2) Which households are most vulnerable?

• (3) Reconsidering vulnerables’ category needed?

• (4) Why energy poverty could be a hidden risk in Japan?
Methodology

• **Original Surveys** Conducted for this study (December 2018 ~ January 2020)

• EP Rate Estimation Coefficient selected as “10% Indicator”

• **Comparison** of existing data vs. original data

• Statistical Analysis (Regression, Std. deviation, Students T-test, Pearson chi-square test)
  • Why is an original survey necessary amid relative preexisting data?

Difference of original surveys in comparison to existing data

*National Survey of Family Income and Expenditure (NSFIE)*
Methodology – Data Selection strategy

**National Survey of Family Income and Expenditure**

**Strengths**
- Large sample (~ 50,000)
- Reliable
- National level
- Complete responses
- Breakdown within category

**Weaknesses**
- Categorical limitation
- Outdated (2014)
- Irregular (5 yrs)
- Lack of in-depth energy oriented actions & Behaviors
- Regional inadequacy
- Data ambiguity
- Seasonal focus

Original Survey Conducted

4 pages – 33 questions

- Demographics
- Energy Carriers
- Consumption Pattern
- Energy Oriented Actions & Behaviors

Introduction | Literature Review | Methods | Results | Conclusion
# Methodology – Survey Details

### Total Sample Number
724 households

<table>
<thead>
<tr>
<th>Detail</th>
<th>Tokyo City (165)</th>
<th>Beppu City (164)</th>
<th>Tokyo Students (166)</th>
<th>Beppu Student (229)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Distribution Amount</strong></td>
<td>1300</td>
<td>1800</td>
<td>700</td>
<td>Online</td>
</tr>
<tr>
<td><strong>Response By Gender</strong></td>
<td>M: 64 (39.0%) F: 100 (61.0%)</td>
<td>M: 61 (31.9%) F: 100 (62.1%)</td>
<td>M: 137 (83.0%) F: 28 (17.0%)</td>
<td>M: 108 (47.4%) F: 120 (52.6%)</td>
</tr>
<tr>
<td><strong>Response Rate</strong></td>
<td>13%</td>
<td>9%</td>
<td>24%</td>
<td>-</td>
</tr>
<tr>
<td><strong>Distribution Method</strong></td>
<td>Post Box</td>
<td>Post Box</td>
<td>Tokyo Tech Campus Internal Mailing Service</td>
<td>Ritsumeikan APU On-campus distribution</td>
</tr>
</tbody>
</table>

**Response by age**

- < 30: 9%
- 30 - 39: 9%
- 40 - 49: 5%
- 50 - 59: 7%
- 60 - 69: 9%
- 70 - 79: 9%
- 80+: 4%

**Student:** 89.5%
**Non-Student:** 10.5%
Results (1) – EP condition in Japan

**Current Study**

**EP rate by Survey Area**

- Kanto: 8.4%
- Tokyo: 10.6%
- Kyushu: 12.7%
- Beppu: 15.7%

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**Existing Literature [8]**

- 2004: 4.7%
- 2007: 6.1%
- 2010: 6.8%
- 2013: 8.4%

Constant Increase

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**Current Study**

- 2020: 13.2%

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- Slight decrease from 2014 [12]
- Rebound since 2016 [5]

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[5] Chapman et al., 2019
[12] Okushima, 2019
* MEPI Indicator
**Results (2) – Vulnerable categories by income**

- Income decile I & II surpass EP threshold
- Higher income decile (i.e. higher income), lower EP ratio

---

Original Findings

- Income decile I & II surpass EP threshold
- Higher income decile (i.e. higher income), lower EP ratio

Existing Literature

[Okushima, 2016]

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**Introduction**

**Literature Review**

**Methods**

**Results**

**Conclusion**
Results (2) – Vulnerable categories by age

I) Highest rate of EP observed for households above 65 years old

II) 20-30 age group

III) Lowest for 30-65

[Chapman et al., 2019]
**Students T-test:** Determine statistical significance between two data sets of normal residents and students

- **H₀:** No difference between categories
- **H₁:** Difference between student and city is statistically significant

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### Results (3) – Reconsideration in categories?

#### Beppu ordinary households vs. student households

<table>
<thead>
<tr>
<th>Source</th>
<th>Test Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Levene's Test for Equality of Variances</td>
<td>F = 4.490, Sig = 0.35, t = -2.505, df = 313, Sg (2-tailed) = 0.013</td>
</tr>
<tr>
<td>t Test for Equality of Means</td>
<td>Mean Difference = -0.02349, Std. Error Difference = 0.00933, 95% CI: Lower -0.04194, Upper -0.00504</td>
</tr>
</tbody>
</table>

Results reject the null hypothesis and accept alternative hypothesis.

#### Tokyo ordinary households vs. student households

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<th>Source</th>
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</thead>
<tbody>
<tr>
<td>Levene's Test for Equality of Variances</td>
<td>F = 20.334, Sig = 0.000, t = -3.019, df = 210, Sg (2-tailed) = 0.003</td>
</tr>
<tr>
<td>t Test for Equality of Means</td>
<td>Mean Difference = -0.03429, Std. Error Difference = 0.01136, 95% CI: Lower -0.05667, Upper -0.01190</td>
</tr>
</tbody>
</table>

Results reject the null hypothesis and accept alternative hypothesis.

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**Original Findings**

- **α = 0.05**
- **Sig. ≥ 0.05**

=> Significant difference in EP rates between ordinary and student households

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**Introduction**

**Literature Review**

**Methods**

**Results**

**Conclusion**
### Results (3) – Reconsideration in categories?

#### Beppu Residents
<table>
<thead>
<tr>
<th>Energy Expenditure to Income Ratio</th>
<th>N</th>
<th>Valid</th>
<th>Missing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>.05</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Median</td>
<td>.04</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Std. Deviation</td>
<td>.06</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Tokyo Residents
<table>
<thead>
<tr>
<th>Energy Expenditure to Income Ratio</th>
<th>N</th>
<th>Valid</th>
<th>Missing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>0.04</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Median</td>
<td>0.02</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Std. Deviation</td>
<td>0.03</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Beppu Students
<table>
<thead>
<tr>
<th>Energy Expenditure to Income Ratio</th>
<th>N</th>
<th>Valid</th>
<th>Missing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>0.08</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Median</td>
<td>0.05</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Std. Deviation</td>
<td>0.09</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Tokyo Students
<table>
<thead>
<tr>
<th>Energy Expenditure to Income Ratio</th>
<th>N</th>
<th>Valid</th>
<th>Missing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>0.07</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Median</td>
<td>0.03</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Std. Deviation</td>
<td>0.13</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**EP Threshold**
- \( \mu + \sigma \)
- \( \mu + 2 \sigma \)
- \( \mu_{BU} + \frac{\sigma_{BU}}{2} \)
- \( \mu_{TU} + \frac{\sigma_{TU}}{2} \)
Results (4) – Why is it a hidden threat?

**Original Findings**

<table>
<thead>
<tr>
<th>Reasons to reduce domestic energy consumption</th>
<th>Count</th>
<th>% / Column N</th>
<th>Count</th>
<th>% / Column N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Can't Afford</td>
<td>167</td>
<td>34.6%</td>
<td>122</td>
<td>31.5%</td>
</tr>
<tr>
<td>Climate change &amp; Emissions</td>
<td>141</td>
<td>45.6%</td>
<td>93</td>
<td>24.0%</td>
</tr>
<tr>
<td>Outdoor time spending</td>
<td>21</td>
<td>6.8%</td>
<td>120</td>
<td>31.0%</td>
</tr>
<tr>
<td>Other</td>
<td>39</td>
<td>12.6%</td>
<td>6</td>
<td>1.6%</td>
</tr>
<tr>
<td>Nothing</td>
<td>74</td>
<td>23.9%</td>
<td>64</td>
<td>16.5%</td>
</tr>
</tbody>
</table>

- Multiple response allowed

**Original Findings**

<table>
<thead>
<tr>
<th>Actions taken to curb domestic energy consumption</th>
<th>Count</th>
<th>% / Column N</th>
<th>Count</th>
<th>% / Column N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use energy at cafe, library etc.</td>
<td>72</td>
<td>22.2%</td>
<td>195</td>
<td>49.9%</td>
</tr>
<tr>
<td>Upgrade appliances</td>
<td>132</td>
<td>40.7%</td>
<td>126</td>
<td>32.2%</td>
</tr>
<tr>
<td>Dwelling insulation</td>
<td>81</td>
<td>25.0%</td>
<td>25</td>
<td>6.4%</td>
</tr>
<tr>
<td>Scheduling applications</td>
<td>14</td>
<td>4.3%</td>
<td>63</td>
<td>16.1%</td>
</tr>
<tr>
<td>Other</td>
<td>62</td>
<td>19.1%</td>
<td>29</td>
<td>7.4%</td>
</tr>
<tr>
<td>None</td>
<td>67</td>
<td>20.7%</td>
<td>43</td>
<td>11.0%</td>
</tr>
</tbody>
</table>

- Multiple response allowed

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- Waste minimization (もったいない)
- Saving resources
- Access to hot spring (温泉)

- Endure (我慢)
- Adjust clothes
- Using cheaper sources (Kerosene)

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**Pearson Chi-Square Tests**

<table>
<thead>
<tr>
<th>Reason for reducing energy consumption</th>
<th>Chi-square</th>
<th>df</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actions taken to curb energy consumption</td>
<td>172.340</td>
<td>6</td>
<td>.000*</td>
</tr>
<tr>
<td>Reasons to reduce energy consumption</td>
<td>139.774</td>
<td>5</td>
<td>.000*</td>
</tr>
</tbody>
</table>

Results are based on nonempty rows and columns in each innermost subtable.

* The Chi-square statistic is significant at the .05 level.
Conclusion - Back to the Research Questions

(1) What is the condition of EP in Japan?
Increase from 4.7% in 2004 to 8.4% in 2013. Slight decrease from 2014, Increase expected from 2016. Estimated at 13.2% in 2019

(2) Type of households most vulnerable?
Single/couple elderly, Single parents with child(ren), ages 65+ followed by 20-30, 3 lowest income deciles, lower income → higher EP rate

(3) Reconsideration of EP categories needed?
Perhaps! Results show high EP rates for students in comparison to normal residents

(4) Why is it a hidden risk?
Characteristics of damaging consumers’ actions are not investigated and reflected on national data → underestimation, ineffective countermeasures and worsened situation
Reference List


[8] Okushima, S., 2016. DOI: https://doi.org/10.1016/j.enpol.2016.09.005
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[16] Morris, J. & Genovese, A., 2018. DOI: https://doi.org/10.1016/j.enpol.2018.05.032

Thank You!
Questions
Suggestions
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Amin Nazarahari