A survey on residential air conditioner in Japan: Selection processes and methods of use

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Abstract
In Japan, air conditioners are commonly selected on the basis of the calculating methods of the cooling and heating area for room air conditioners created in 1964 (a standard of reference based on the size of a given room). It is commonly called "Tatami Number Guideline". However, it must be considered characteristics of the house, lifestyle of the residents, and other factors in addition to the size of the room for efficient air conditioner usage. And it is important to install air conditioners with capacities that meet these factors. Against this backdrop, we conducted research to the current methodology used to select air conditioner(by telephone interview), and the manner in which consumers use them(by web survey).

Results of telephone interviews with electronics stores revealed a correlation between warmer climates and the likelihood of stores to recommend air conditioners with capacities larger than those recommended by the Tatami Number Guideline. Moreover, some of these stores mentioned that they recommended these air conditioners because they were unable to assess the lifestyle of consumers. In addition, results of an online survey of general consumers showed a trend of consumers living in warm climate areas using air conditioners with capacities larger than those recommended by the Tatami Number Guideline. There were regional differences in seasonal air conditioner demand. However, there were no differences with respect to usage time and the set temperature. The time of air conditioner usage was directly impacted by the number of hours spent at home by respondents during weekdays and weekends.

Keywords - Air Conditioners, Selection process, Methods of use, Telephone interviews, and Online survey

1. Introduction
The increase in the penetration rate of residential air conditioners continues year after year. Taking into account the increased usage of air conditioners as heating units, their highly efficient usage will become increasingly important in terms of energy savings. Climate conditions,
housing characteristics, and lifestyle (how the units are used) affects the necessary capacity for each unit, and it is reported that selecting a unit with too much capacity for one’s needs leads to low-efficiency usage, greater CO2 emissions and increased energy use\textsuperscript{(1,2)}. It is, therefore, important to select the right equipment for one’s residence in order to maximize efficiency.

We conducted a survey to understand the reality of how residential air conditioners are selected and used. Since it was presumed that most people select their units based on store recommendations rather than independently, we conducted a phone survey with sales staff working in home electronics stores and asked them how they sell air conditioners. Secondly, we conducted a survey over the web targeting the general consumer to ascertain how people actually use their air conditioners. In this paper we showed the result of the 30 stores throughout the country about the phone interview. For the web survey results we organized our report using categories such as the unit capacity, usage hours, usage period, and the relation between temperature settings and actual temperatures achieved in Morioka (Region 3), Sendai (Region 4), Tokyo (Region 6), Osaka (Region 6), and Fukuoka (Region 6).

2. Method

2.1 Phone Interview with Sales Staff in Home Electronics Stores Regarding Air Conditioner Selection and Recommendation

Telephone interviews were conducted with multiple stores (30 stores) in each of the eight regional zones according to the Standards of Judgment for Residential Construction Clients\textsuperscript{3).} Sales staff were asked how they provided explanations or recommendations to clients regarding what units to purchase. The interviews were conducted on July 11th and August 8th, 2012, and then again on December 20th and 28th, 2013. The specific questions were: “If one were to live near your shop, what kind of capacity should one consider for purchasing an air conditioner?” and “Would it be appropriate to use the Tatami Number Guidelines?”

2.2 Web Survey on General Consumers’ Usage Habits of Air Conditioner

We requested a external survey institution conduct a web survey (closed survey) on those who currently use air conditioners. The research period was from February 20th to the 24th and 1,616 samples were obtained. The male to female ratio of those who were surveyed was 1:1, and age groups were divided into equal parts between those in their 20’s, 30’s, 40’s, 50’s, and over 60’s at 20% for each. The number of people selected to take the survey was matched to the population distribution of the prefecture being surveyed and only respondents using air conditioners qualified for the survey. Questions included demographic information, characteristics of the home of
the respondent (such as the type of residence and the direction it faces etc.), how the respondent uses their air conditioner (temperature settings, time of the day of usage, the usage period of the air conditioners, etc.). N number of each of the five regions that we are reporting on this paper are Morioka (Region 3) = 35, Sendai (Region 4) = 33, Tokyo (Region 6) = 224, Osaka (Region 6) = 120, and Fukuoka (Region 6) = 83. In this survey, we received answers regarding what was the room of the residence, which had the main air conditioner installed, and how that air conditioner was being used.

3. Result

3.1 Phone Interview with Sales Staff in Home Electronics Stores Regarding Air Conditioner Selection and Recommendation

The locations of the surveyed stores are shown in Figure 1. It should be noted that the Tatami Number Guidelines that is often used in such places as the home electronics stores were calculated and set based on Tokyo with no consideration for regional differences in environmental conditions and local climate. Table 1 shows the list of the responses regarding the Tatami Number Guidelines. If the air conditioners were mainly used as the cooling, the Tatami Number Guidelines are used in Regions 1 and 2. However, it is not an issue to use the units in slightly larger rooms In Regions 3 to 5 they were followed the Tatami Number Guideline. In Regions 6 to 8 they suggested the one grade higher than what the Tatami Number Guidelines recommended were typically used. When the air conditioner is mainly used as the heating, the usage rate in Regions 1 and 2 is low. However, in every
other region they answered that it is better to purchase a unit that is one grade above what is being recommended in the Tatami Number Guidelines. The sales staff at each store recommended the capacity of air conditioners with using the Tatami Number Guidelines as reference. In addition, they suggested the capacity with considering the weather, housing conditions, the way to use the air conditioner, and the other heating devices and so on. However, there were also comments that if when they made the recommendations they could not quite grasp the consumer’s housing characteristics or usage habits, and they therefore had to recommend units with a relatively larger capacity. And yet at the same time, because of the the low costs in cold regions, and the safety of the elderly in other regions, some respondents also answered that the air conditioners are increasingly being used as the heating.

<table>
<thead>
<tr>
<th>Region</th>
<th>Yearly mean temperature</th>
<th>Cooling</th>
<th>Heating</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5.8°C</td>
<td>- The Tatami Number Guidelines</td>
<td>- Usage rate is low.</td>
</tr>
<tr>
<td>2</td>
<td>7.5°C</td>
<td>- It is not an issue to use the units in slightly larger rooms.</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>10.2°C</td>
<td>- The Tatami Number Guidelines</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>11.6°C</td>
<td>- The Tatami Number Guidelines</td>
<td>- One larger grade than the Tatami Number Guidelines</td>
</tr>
<tr>
<td>5</td>
<td>13.3°C</td>
<td>- The Tatami Number Guidelines</td>
<td>- One larger grade than the Tatami Number Guidelines</td>
</tr>
<tr>
<td>6</td>
<td>15.7°C</td>
<td>- The Tatami Number Guidelines</td>
<td>- One larger grade than the Tatami Number Guidelines</td>
</tr>
<tr>
<td>7</td>
<td>17.4°C</td>
<td>- One larger grade than the Tatami Number Guidelines</td>
<td>- One larger grade than the Tatami Number Guidelines</td>
</tr>
<tr>
<td>8</td>
<td>22.7°C</td>
<td></td>
<td>- Usage rate is low.</td>
</tr>
</tbody>
</table>

3.2 Web Survey on General Consumers’ Usage Habits of Air Conditioners

3.2.1 The relation between housing characteristics and the air conditioner’s unit capacity

Table 2 shows the percentages of the respondents’ answers regarding their housing characteristics. To determine the direction the respondents’ home faced we considered the direction the sweep-out windows faced as a way to allow in the most sunlight. In the case where there were no sweep-out windows, we then selected a medium-height window. As a result, most regions showed there was a higher ratio of residences facing south, but compared to other regions Osaka had many facing east. As to the type of windows being used, the cold the region (e.g. Morioka, Sendai), the more heat insulated materials such as “wood or plastic sash frames” and “low
radiation double glazing windows” were used. As to the size of rooms for which the air conditioners are being used, averages were an 8 to 9 Tatami size (13-15m²) in Morioka and Sendai, and a 6 to 7 tatami size (10-11m²) in Tokyo and Osaka.

Figure 2 shows the relation between the size of the room based on the number of standard tatami mats and the air conditioner’s unit capacity. We only used the answers we were able to obtain regarding unit capacity. The shaded portion is Tatami Number Guidelines or smaller. Expect for Morioka, most regions had the air conditioners with larger capacity than what was recommended in the Tatami Number Guidelines.

3.2.2 The Set Temperature of Air conditioners

Figure 3 shows the set temperature of the cooling in each region. Mostly, temperatures were set at 27 to 28°C, but about 10% of answers indicated a temperature setting between 24 to 26°C.

Figure 4 shows the set temperature of the heating in each region. In contrast to the usage of the cooling, there was a high rate in which the units were not used at all. In Sendai, 50% did not operate the heating, and in Morioka that jumped to 70%. Those who used the units as a heater, however, had set it roughly between 20 to 25°C and spread out at about 10% each. Unlike being used as the cooling, there was no specific temperature that stood out as the standard setting.

When the temperature setting and the actual temperature achieved were compared, 60% to 80% of respondents answered that in both cases, with heating and the cooling, they achieved the temperature setting they had set. (Answers from subjects that “did not use the units” and from those who were “Realization temperature is unclear.” were removed from these statistics.)

Table 2 Percentages of the respondents’ answers regarding their housing characteristics

<table>
<thead>
<tr>
<th>Percentage[％]</th>
<th>Housing Characteristics</th>
<th>Floor</th>
<th>Direction</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Single-family house</td>
<td>Collective house (Corner room)</td>
<td>Collective house (Intermediate room)</td>
</tr>
<tr>
<td>Morioka(n=35)</td>
<td>82.9</td>
<td>14.3</td>
<td>2.9</td>
</tr>
<tr>
<td>Sendai(n=33)</td>
<td>48.5</td>
<td>30.3</td>
<td>21.2</td>
</tr>
<tr>
<td>Tokyo(n=224)</td>
<td>37.9</td>
<td>35.0</td>
<td>29.0</td>
</tr>
<tr>
<td>Osaka(n=120)</td>
<td>49.2</td>
<td>22.5</td>
<td>28.3</td>
</tr>
<tr>
<td>Fukuoka(n=83)</td>
<td>50.6</td>
<td>20.5</td>
<td>28.9</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Percentage[％]</th>
<th>Window</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Single glass / Metal sash flame</td>
</tr>
<tr>
<td>Morioka(n=35)</td>
<td>42.9</td>
</tr>
<tr>
<td>Sendai(n=33)</td>
<td>45.5</td>
</tr>
<tr>
<td>Tokyo(n=224)</td>
<td>45.1</td>
</tr>
<tr>
<td>Osaka(n=120)</td>
<td>54.2</td>
</tr>
<tr>
<td>Fukuoka(n=83)</td>
<td>54.2</td>
</tr>
</tbody>
</table>
Figure 2 The relation between the size of the room based on the number of standard tatami mats and the air conditioner’s unit capacity

Figure 3 The set temperature of the cooling in each region

Figure 4 The set temperature of the heating in each region
3.2.3 The Usage Time of the Air Conditioners

In case of the cooling, weekdays from 18:00 to 24:00 had the highest usage, and on holidays and weekends 6:00 to mid-day had the highest usage in all region. In case of the heating, in the cold regions like Morioka and Sendai, we found that the heating was not used as much as the cooling. However, regardless of region, weekday usage was highest between 6:00 to 9:00 and from 18:00 to 24:00. In the case of the holidays, since we do not have a large enough N number. So we use these only as guide. The highest usage was from 6:00 to mid-day. There were answers that they used the cooling or heating with 24 hours non-stop in Fukuoka.

3.2.4 The Usage Period of the Air Conditioners

Figure 5 shows the usage rate of the cooling in each region. The warm regions (Tokyo, Osaka, Fukuoka) started usage the cooling earlier and finished usage it later than the cold regions (Morioka, Sendai) under the inference of the outside temperature. In cold and warm regions there was as much as a half-month’s difference in when the usage rate went over 20%. However, there were no differences of usage rate between the regions in early August which was the highest usage.

Figure 6 shows the usage rate of heating in each region. The period of usage heating in cold regions was longer than that in warm regions. And when the usage rate goes over 20%, there was about a month difference in
when the heating were turned on. Though all regions show the highest usage during January and February, the colder regions used less of the heating than the warmer regions. This was particularly noticeable in Morioka where the outside temperature is very low.

4. Considerations

The results of the phone interviews with sales staff showed that in warm regions there was a tendency to recommend units with greater capacity than what is recommended in the Tatami Number Guidelines. From the web survey of general consumers, we learned that, compared to cold regions, warm regions tended to have installed units with capacities in excess of what is recommended in the Tatami Number Guidelines. This indicates that the sales staff recommendations have an influence in the purchasing decision of the general consumers. In previous studies it is stated that the Tatami Number Guidelines already recommend more capacity than necessary\(^1\)\(^2\). However, in warm regions the sales staff tended to recommend air conditioners with capacities larger than those recommended by the Tatami Number Guideline. On the other hand, usage of the air conditioners as the heating is lower in cold regions, and even when used during the coldest time of the year, usage was less than in the warm regions. Conceivably as the usage starts around October, when the temperature starts to drop in autumn, they first turned on the heating, however, then gradually they started to use it.
in conjunction with other heating devices. It might be that the respondents
needs the air conditioners as cooling in cold regions where the usage rate of
air conditioner as heating is low. However, summer outside temperatures in
cold regions are lower than that in the warm regions. So these respondents
might have had less of a need to buy a unit with a larger capacity.

There were no major differences in set temperature and usage of time
differences by region. The time of air conditioner usage was directly
impacted by the number of hours spent at home by respondents during
weekdays and weekends.

The investigation from the interviews with the sales staff has revealed
that the low costs and safety of the elderly were the key factor when
installing air conditioners. Thus it might be that the usage rate of the air
conditioners as heating will increase. Due to the lack of information on the
housing characteristics or the lifestyle, there is a tendency to recommend a
larger capacity than is needed just to be on the safe side. From the general
consumers’ survey the wide variety housing characteristics and lifestyle were
confirmed once again. If we develop the selecting system of air conditioners
with consideration of the housing characteristics and the lifestyle of
consumers, it might prevent the selecting the air conditioners with excessive
capacity, and turn might be able to help reduce overall energy use.

5. Conclusion

To understanding of how consumers select their air conditioners and how
they are being used, we first conducted phone interviews with sales staff in
home electronics stores, and asked how they sell or recommend air
conditioners to consumers.

Second, we conducted a web-based survey with general consumers’
participation and asked how they use their air conditioners. Here are the
main findings:

[The findings from the interviews with sales staff]

- When consumers used the air conditioners mainly as the cooling,
  there is a tendency to recommend one grade above what is being
  recommended in the Tatami Number Guidelines, especially in warm
  regions.
- When consumers used the air conditioners mainly as the cooling,
  there is a tendency to recommend one grade above what is being
  recommended in the Tatami Number Guidelines, except for in Hokkaido
  where the usage rate of heating is low.
- Because of the cost in cold regions, and the safety of the elderly in
  other regions, some respondents also answered that the air conditioners
  are increasingly being used as heating.
- Due to a lack of information on the housing characteristics and usage
  habits of the consumer, there is a tendency among sales staff to
  recommend a larger capacity unit than is needed.
[Findings from the General Consumers’ Survey]

- The general consumers’ survey indicated that there is a tendency to install units that one grade above what is recommended in the Tatami Number Guidelines in warmer regions.
- There were regional differences of the usage period of the cooling and the heating.
- There were no differences with respect to usage time and the set temperature. The time of air conditioner usage was directly impacted by the number of hours spent at home by respondents during weekdays and weekends.

References