Automatic dishwashers: efficient machines or less efficient consumer habits?

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Abstract

Increasing costs for energy and water influence consumer decision making when purchasing white goods, such as dishwashers. Since the implementation of the European Energy Label, considerable improvements in water and energy consumption of dishwashers has been achieved, and for consumers, efficiency has become one of the main buzzwords when buying any major new household appliance. However, ownership of an efficient dishwasher in itself does not guarantee savings in energy and water during the course of the dishwashing process. Conservation of resources also requires changes in consumer behaviour. This paper provides empirical data on consumers’ dishwashing habits in everyday life in four European countries, deals with the influence of their behaviour on the efficiency of the dishwashing process and highlights savings potentials in the usage of dishwashers. It reports on the results of a survey involving a total of 1209 online interviews conducted in winter 2006/2007. The survey data have been analysed to reveal the importance of various product attributes for consumers and show that low water and energy consumption values are the most important consideration for the respondents in terms of their purchasing decision. But this is compromised, at least in part, by less efficient dishwasher use, e.g. in pre-rinsing dishes before placing them into the dishwasher and in the programme choice. In addition, differences in manual dishwashing practices between households with and without a dishwasher, as well as between countries, will be shown. Finally, conclusions are drawn for greater sustainability in the dishwashing process.

Introduction

In times of rising energy costs, consumers are increasingly focused on using energy-efficient household appliances because saving energy equates to reducing costs in everyday use. But the purchase of an efficient appliance is not automatically linked with noticeable savings. Efficiency just means improved technologies to increase the energy performance of the product and to lower resource consumption with less dependence upon consumer habits and use patterns (Emmel and Leech, 2003).

When it comes to dishwashers, appliance manufacturers offer a wide range of models for every kind of consumer segment, equipped with various gadgets, such as interior lighting, adjustable baskets, additional spray arms and special programmes, e.g. for beer glasses. Besides these special features, the implementation of the European Energy Labelling in 1999 swayed the decisions of the majority of consumers when purchasing white goods. Apart from the dishwashers’ cleaning and drying performance, the Energy Efficiency Index on the label is used to specify an energy efficiency ranking divided into classes from G (least efficient) to A (most efficient) to inform consumers about the energy efficiency range of existing products. The more efficient the product, the less energy it needs and the more consumers get for their money. So, consumers started to trust the energy label to support their decisions when buying a new dishwasher (Sammer and Wüsterhagen, 2006; GreenLabelsPurchase, 2009).

In its turn, the label attracted the market and dishwashers became more efficient: In 1999, within the European Committee of Domestic Equipment Manufacturers (CECED), several dishwasher manufacturers, representing 90% of the European market, gave a voluntary commitment on reducing the energy consumption of domestic dishwashers by a reduction of the European fleet consumption and a stepwise phasing out of less efficient appliances in certain energy label classes (CECED, 2003). Since then, the average energy consumption per cycle has been considerably reduced by nearly 30%, from 1.43 kWh down to 1.035 kWh in 2005. For the same year, the average energy consumption of the most common dishwasher size, the 12-place settings machines (about 80% of all models), was very close to the limit of the best energy label class A, which is at 1.05 kWh/cycle. A remarkable improvement can be also seen in the fact that in 2005, about 90% of dishwashers belonged to energy efficiency class A and none
were worse than class C, whereas in 1999, only about 9% have been located in class A but one-third have been worse than class C (Stamminger, 2007).

The reduction of dishwasher energy use has mostly been achieved using less water per cycle because of improved motor pump technologies and optimized wash system hydraulics (Dries, 2008). From 1990 to 2005, the average water consumption for standard size machines has been more than halved to around 13 l per cycle (Stamminger, 2006). Very modern dishwashers use even less than 10 l to clean a whole load.

However, more and more households in the European Union (EU) now own a dishwasher. The saturation of the dishwasher market in 2007 was relatively high in Germany (64%) and Sweden (60%) compared with the west EU average (48%) and the relatively low market penetration in Italy (37%) and the UK (33%). From 1997 until 2007, 20% more households in Germany possessed a dishwashing machine (ZVEI, 2008; F.-J. Wipperfürth, unpublished). Therefore, growth potentials exist especially in Italy and the UK.

But an increasing number of households possessing an energy and water-efficient dishwasher are not necessarily attended by savings in the consumption of energy and water for dishwashing. Savings in the consumption of energy and water for dishwashing is, to a large extent, controlled by the actions of the consumer. ‘Through such decisions as machine versus manual washing, the extent of pre-rinsing dishes, the selection of dishwasher cycles, and how fully and efficiently the dishwasher is loaded, consumers ultimately decide the water and energy use involved in the dishwashing process’ (Emmel et al., 2003). Pre-washing and soaking of dishes in particular increases the consumption values for a dishwasher load and lowers efficiency overall, but the reasons for doing so vary. For example, many dishwasher users do not believe that dishes will become clean if not rinsed or have had the experience that dishes emerged from the dishwasher dirty without rinsing. But pre-rinsing is often just a matter of habit (Emmel et al., 2003). However, dishwasher manufacturer advises that pre-rinsing is not necessary, and recommend scraping or wiping leftovers off the dishes instead. New dishwashers are designed to cope with food scraps.

Even with the presence of a dishwasher in a household, manual washing up does not become completely redundant. There are always dishes that are too bulky or not suitable for the dishwasher. What is critical in terms of resource consumption is the precise manner in which the dishes are washed. Various organizations [e.g. Forum Waschen (2008), Germany; Waterwise (2008), UK; Cleaning101.com, USA] advise for the dishes to be done in a filled sink or bowl, as they suggest that this is more economical than washing up under running tap water.

The behaviour of the consumer in the handling of the dishwasher and additional manual washing up has an impact on the overall efficiency of the dishwashing process. Therefore, the target is to investigate how consumer habits in daily life influence the resource consumption for dishwashing whether a dishwasher is available or not. In addition, differences in consumer behaviours between different European countries will be documented. Finally, the savings potential in usage of the dishwasher will be highlighted by means of selected examples, such as programme availability and choice, pretreatment and manual washing practices.

Materials and methods

Sample

In order to gather varieties of dishwashing habits in Europe, and different wishes and expectations towards a new dishwasher, in winter 2006/2007, an external market research firm (ODC Services GmbH) conducted an online survey collecting 1206 interviews from a minimum of 250 households in each of four European countries (Germany, Sweden, Italy and the UK), whereof at least 75 households per country did not possess a dishwasher. Besides a quotation by the availability of household appliances, the sample was normalized using Eurostat data for household sizes and age distributions of the households in each of the countries.

Questionnaire

The questionnaire included 42 questions covering demographic characteristics of the participants, their considerations during the purchasing process and questions about the dishwashing habits, such as the usage of the dishwasher and manual washing practices. The data have been analysed using spss Statistics (SPSS Inc., Chicago, IL, USA) version 14 and 15 for Windows and Microsoft Office Excel 2003.

Results

Respondents

As shown in Table 1, the survey was conducted in almost equal parts in the four countries (around 25%). With 63%, the proportion of women was substantially higher than that of men. The distribution of age groups and household sizes corresponds to the pre-

Table 1 Demographic characteristics of respondents

<table>
<thead>
<tr>
<th>Demographic characteristics</th>
<th>No. (%) of respondents</th>
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<tbody>
<tr>
<td>Country (n = 1206)</td>
<td></td>
</tr>
<tr>
<td>Germany</td>
<td>331 (27.4)</td>
</tr>
<tr>
<td>UK</td>
<td>311 (25.8)</td>
</tr>
<tr>
<td>Sweden</td>
<td>256 (21.2)</td>
</tr>
<tr>
<td>Italy</td>
<td>308 (25.5)</td>
</tr>
<tr>
<td>Gender (n = 1206)</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>760 (63)</td>
</tr>
<tr>
<td>Male</td>
<td>446 (37)</td>
</tr>
<tr>
<td>Age group (n = 1206)</td>
<td></td>
</tr>
<tr>
<td>19 years and younger</td>
<td>0 (0)</td>
</tr>
<tr>
<td>20–29 years</td>
<td>217 (18.0)</td>
</tr>
<tr>
<td>30–39 years</td>
<td>285 (23.6)</td>
</tr>
<tr>
<td>40–49 years</td>
<td>312 (25.9)</td>
</tr>
<tr>
<td>50–59 years</td>
<td>164 (13.6)</td>
</tr>
<tr>
<td>60 years or older</td>
<td>228 (18.9)</td>
</tr>
<tr>
<td>Household size (n = 1206)</td>
<td></td>
</tr>
<tr>
<td>1 person</td>
<td>210 (17.4)</td>
</tr>
<tr>
<td>2 persons</td>
<td>394 (32.7)</td>
</tr>
<tr>
<td>3–4 persons</td>
<td>498 (41.3)</td>
</tr>
<tr>
<td>5 and more persons</td>
<td>104 (8.6)</td>
</tr>
</tbody>
</table>
settings with smaller deviation (maximum ± 5%) because of the sample size. In terms of the respondents’ ages, the biggest shares were age groups 30–39 years (23.6%) and 40–49 years (14.5%), especially identified as family households. About 17% of all participants lived in single-person households and about 9% were extended households with at least five members.

**Consumer purchasing behaviour**

Participants were asked to indicate their preferences by rating the importance of their considerations when purchasing a new white goods appliance like a washing machine or a dishwasher. Respondents rated a maximum of 4 out of 11 available features (Table 2). The research found that low consumption values for water and energy are the most important consideration (83%), followed by excellent cleaning performance (73%) and a low noise level of the appliance while operating (48%). Also high in rank is the price of the appliance, with 37% of respondents saying that a low price is important to their purchase decision. At the end of the scale are lower detergent consumption (16%), higher capacity of the appliance (12%) and an innovative aesthetic design (5%).

In cross-country comparisons, it emerges that choosing an energy and/or water-efficient machine is the most important criterion for almost all countries. Only respondents from the UK place greater importance on dishwasher performance. At 95%, German consumers ranked low energy and water consumption values the highest by far. Ranking third in importance, good ratings in terms of the energy label are also crucial in the German market. Swedish consumers demand a noise-reduced appliance (69%), whereas UK consumers are less concerned about this particular feature (34%). They rank the purchase price third (47%). In total, a high variety of cleaning programmes and options is not that important in respondents’ consideration, but compared with German or Swedish consumers (10%/14%), Italians and the British place a higher importance on this (each 25%).

**Age distribution of household dishwasher**

In order to check to what extent the consumer in this sample was influenced by the energy label during the purchase process, the age of the household dishwashers was analysed: Over half of all dishwashers were less than 5 years old, with 90% less than 10 years (Fig. 1). The analysis also shows that dishwashers with the highest average age can be found in Italy and Germany (5.5 years). The newest machines with an average age of 4.4 years are found in UK households. At the time of the survey, the energy label had already been established for around 7.5 years. Fig. 1 shows that 75–85% of all dishwashers were bought after the implementation, so most of the respondents somehow received information about the energy and water efficiency of their appliances while purchasing.

**Programme availability and choice**

The consumers were then asked in detail about the kinds of programmes their dishwasher had and how often they used these in the categories ‘always’, ‘often’, ‘sometimes’, ‘rarely’ or ‘never’. According to the answers given, the ‘normal/regular wash’ programme is most commonly available (99%), followed by ‘quick wash’ (87%), ‘rinse/rinse and hold’ (87%) and the ‘intensive’ programme (86%). Participants thought that the efficient ‘eco-wash’ programme (80%) and the sensor-controlled ‘automatic wash’ (74%) were less frequently available in their dishwasher (Table 3).

With the help of the respondents’ indication about the average frequency of use of the dishwasher per week and their answers regarding programme use (always = 100%, often = 75%, sometimes = 50%, rarely = 25%, never = 0%), the programmes’ share in the weekly dishwasher use has been calculated. It shows that in over 40% of all cases, ‘normal/regular wash’ or the ‘heavy wash/pots and pans/power scrub’ programme is chosen to wash the dishes. Even though the households’ dishwashers do not seem to offer the ‘eco’ programme as often as other programmes, this cleaning programme has the second largest proportion (17%) on the average programme choice. In addition, the figure for ‘automatic wash’ (15%) shows that, if available, this particular feature is chosen relatively frequently. The programme for pretreating dishes before cleaning, ‘rinse/rinse and hold’ is used the least (8%).

**Pretreatment of dishes for the dishwasher**

How participants of this survey pretreat their dishes before placing them into the dishwasher is shown in Fig. 2. This figure shows that

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### Table 2: Respondents were asked: What do you place high importance on when buying a new household appliance? (maximum of four answers allowed)

<table>
<thead>
<tr>
<th>Feature</th>
<th>Germany (n = 331)</th>
<th>UK (n = 311)</th>
<th>Sweden (n = 258)</th>
<th>Italy (n = 308)</th>
<th>Total (n = 1206)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low water and/or energy consumption</td>
<td>95</td>
<td>76</td>
<td>77</td>
<td>81</td>
<td>82.9</td>
</tr>
<tr>
<td>Very good cleaning/washing performance</td>
<td>76</td>
<td>84</td>
<td>59</td>
<td>69</td>
<td>72.5</td>
</tr>
<tr>
<td>Low operating noise emission</td>
<td>42</td>
<td>34</td>
<td>69</td>
<td>52</td>
<td>48.2</td>
</tr>
<tr>
<td>Low purchase price</td>
<td>38</td>
<td>47</td>
<td>31</td>
<td>31</td>
<td>37.1</td>
</tr>
<tr>
<td>Good assessment results on the energy label</td>
<td>44</td>
<td>37</td>
<td>36</td>
<td>28</td>
<td>36.2</td>
</tr>
<tr>
<td>Good dishes/textile protection</td>
<td>39</td>
<td>13</td>
<td>20</td>
<td>24</td>
<td>24.3</td>
</tr>
<tr>
<td>Short programme duration</td>
<td>19</td>
<td>22</td>
<td>33</td>
<td>12</td>
<td>20.9</td>
</tr>
<tr>
<td>A large number of different programmes and options</td>
<td>10</td>
<td>25</td>
<td>14</td>
<td>25</td>
<td>18.3</td>
</tr>
<tr>
<td>Low detergent consumption</td>
<td>19</td>
<td>11</td>
<td>19</td>
<td>17</td>
<td>16.3</td>
</tr>
<tr>
<td>Higher capacity of the appliance</td>
<td>5</td>
<td>16</td>
<td>10</td>
<td>15</td>
<td>11.5</td>
</tr>
<tr>
<td>Innovative aesthetic design</td>
<td>2</td>
<td>6</td>
<td>5</td>
<td>7</td>
<td>5.1</td>
</tr>
</tbody>
</table>

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in Germany (49%) and the UK (50%), the most common practice is to scrape or wipe food leftovers off the dishes, whereas in Sweden (51%) and Italy (43%), the largest proportion of respondents stated that they give the dirty dishes a quick rinse before they are loaded into the dishwasher. Only 14% of households (24% in Germany) do not pretreat dishes at all. Seven to 10% of the participants only pre-rinse or soak heavily soiled items, such as pots and pans, or casserole dishes.
When it comes to dishwashing procedures, the practices are quite different between the countries. In Sweden and Italy in particular, people often did the dishes under continuously running tap water (Fig. 4). The proportion of households with dishwashers that do the dishes manually in this way is almost twice as high as in households without (households with dishwasher, I: 42%/S: 46% vs. without dishwasher, I: 26%/S: 23%). Compared with all the other countries, especially people in the UK with and without dishwasher predominantly wash their dishes in a filled sink or bowl (with dishwasher: 63%; without dishwasher: 72%). Also seen here is the smallest proportion of respondents who clean dishes under running tap water (with dishwasher: 19%; without dishwasher: 7%).

A combined technique, of doing the dishes in a water-filled sink or bowl as well as under running tap water, is very common in Italian households without an automatic dishwasher (45%) and in German households with a dishwasher (42%). It was also found that households with dishwashers generally do the dishes more frequently under running tap water (31%) than households without (17%).

**Summary and conclusion**

Respondents in this survey show a high awareness of the environmental impact of their purchasing behaviour. If asked about the four most important aspects or features when purchasing a new white goods appliance, the research found that an overwhelming part of respondents are focused on buying a household appliance with low water and energy consumption. In total, 83% of the participating household stated this.

But does the desire to have or buy a very water and energy-efficient dishwasher ensure that the consumer acts in a sustainable manner? The research findings are ambiguous on this issue.

The results concerning the age of the household dishwashers indicate that while purchasing their machine, 75–85% of respondents must have been exposed to the energy label, meaning that they received information about the efficiency of the dishwasher they bought and the programme that was used to assess the amount of water and energy use per cycle depicted on the label.

Asked about programme availability and choice, people answered that the ‘normal/regular wash’ and ‘intensive’ programmes get chosen in about 42% of all cycles to clean the dishes. This also implies that in these cases, the dishwasher works with water temperatures around 55–75°C, and consumers are likely to use higher amounts of energy and water than stated on the energy label.

In contrast, the more energy and water-efficient ‘eco-wash’ programme, usually working with water temperatures around 50–55°C, is found in around 80% of all dishwashers but gets chosen in only 17% of all dishwasher cycles. For the cycle choice, it can be concluded that if the cleaning programmes, which work on higher water temperatures, were to be replaced more frequently by the ‘eco-wash’ programme, households could save both energy and water.

But it is not only choosing the right programme that leads to savings. A thoughtful pretreatment of dishes before placing them into the dishwasher is necessary. Dishwasher manufacturers recommend to scrape or to wipe food leftovers off the dishes, and over 50% of respondents either follow this advice or do not carry out any kind of pretreatment. But still, around one-third of the

But are dishwasher users who pre-rinse dishes more satisfied with the cleaning results? A correlation between the pretreatment practice and the satisfaction with the cleaning performance of the dishwasher is given in Fig. 3.

In general, no major differences can be seen between the selected pretreatment routines in terms of ‘dissatisfied’ and ‘very dissatisfied’ dishwasher users (each less than 5%). Also, the proportion of respondents claiming to be ‘satisfied’ and ‘very satisfied’ together is quite balanced (around 85%). ‘Very satisfied’ respondents follow the recommended practice to scrape off dishes (39%); the difference between the extremes ‘pre-rinsing’ and ‘no pretreatment’ is about 5%, just marginal.

**Washing up by hand – still necessary?**

**If so – how?**

Even in households with dishwashers, dishes do still get washed by hand. The reasons are diverse, as shown in Table 4.

The main reason for additional hand-washing processes is that items are too bulky or take too much space in the dishwasher (53%), directly followed (52%) by dishes being needed immediately, such as knives or cooking utensils, and the fact that there are still dishes in use that are not dishwasher safe. In particular, smaller households with one or two members cannot always justify the expense of running the dishwasher (28%) and so that is why they do the dishes by hand. Only 13% of households claimed never to hand wash the dishes; they load everything into the dishwashing machine.
participating households pre-rinse their dishes. In Sweden and
Italy especially, this appears to be a common habit. Instead of
pre-rinsing each single item with water, the ‘rinse/rinse and hold’
programme could be used. But the ‘pre-rinsing’ programme is
only used on average in around 8% of all cycles, although almost
every dishwasher has this kind of option. Furthermore, a corre-
lation between pretreatment habits and the satisfaction with the
dishwasher cleaning performance does not show significant dif-
fferences in terms of either dissatisfaction or satisfaction. Only the
largest share of households, which are ‘very satisfied’, are found to
follow the recommended kind of pretreatment, to scrape/wipe off
leftovers. So, it may be concluded that pre-rinsing will not cause a
dishwasher user to be more satisfied with the cleaning results but
will use more water and – if warm water is used – more energy for
a dishwasher cycle.

Because of the fact that there are always dishes which are
needed immediately, e.g. for cooking, or which are not suitable for
the dishwasher, like wooden items, or are just too big or bulky for
the dishwasher, hand washing up will not become completely
redundant. Another main reason for additional washing up proce-
dures by hand is that dishes are found as too valuable to put into
the dishwasher. The risk that fine glasses and good crockery may
get damaged is too high for 38% of the respondents. Only 13% of
all dishwasher users wash everything in their appliance.

When households with a dishwasher do their dishes by hand,
the survey shows that these households in all countries do it more
frequently under continuously running tap water than households
without a dishwasher. Here, over half of the respondents stated
that they do their dishes in a filled sink or bowl, and another 28% use
a filled sink plus running tap water, usually to give the dishes
a final rinse, to remove the detergent suds. Particularly in Italy and
Sweden, a distinctive habit to wash dishes under running tap water
can be identified, and not only in households with a dishwasher.
Presuming that, in households with a dishwasher, just several
single items get cleaned by hand in most of the times, it could be
recommended that these items are collected over the day, in order
to be washed in a filled sink or bowl later on together.

All in all, the survey findings are ambiguous concerning the
influences on resource consumption: On the one hand, almost
everybody considers better energy and water efficiency as more
important than the price when purchasing a new dishwasher. And
also a large number of households with a dishwasher operate it
as per recommendation, using the ‘eco-wash’ or ‘automatic’ pro-
gramme, and do not pre-rinse. But on the other hand, there are
further opportunities for saving both energy and water in the
dishwashing process by using the ‘intensive’ programme less fre-
frequently and by choosing the ‘pre-rinse’ programme more often
instead of pre-rinsing manually. Also hand dishwashing habits
should be reconsidered. Around one-third of the participating
households with a dishwasher still always do their dishes under
running tap water instead of using a sink or bowl full of water as
recommended.

Further opportunities to improve the consumption of energy,
water and consumers’ satisfaction and costs of dishwashing may
lie in the degree of the dishwashers’ capacity usage, the use of
detergents and the maintenance of the machine. These aspects
were not part of this survey but need to be acknowledged to make
the dishwashing processes more efficient and more sustainable.

More can be done to make consumers aware of how to use
modern dishwasher technologies more efficiently. Even though
dishwashers are available, appreciable effects in the conservation
of energy and water, and costs reduction still require adjustments
or changes to the consumers’ lifestyle and usage behaviour. There-
fore, everybody should take some time to reconsider his/her dish-
washing habits. Especially by the way of pretreating dishes and the
programme choice, the consumer has a great influence on the
efficiency of the dishwasher use.

In addition, manufacturers could do more to help educate con-
sumers about a more sustainable usage. The research showed
that dishwashing habits differ greatly between the four countries
researched, so general hints and tips do not really help. Instead, to improve the efficiency of the whole dishwashing process in households and to increase consumer satisfaction, country-specific information campaigns are necessary.

References


