Influence of external actors in Swedish homeowners' adoption of energy efficient windows

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Abstract: A questionnaire survey of 1010 homeowners (response rate of 59%) in two counties in central Sweden viz., Jämtland and Västernorrland was conducted to understand the influence of external actors on homeowners' decision to install energy efficient windows. We complemented this survey with interview of 12 window sellers/installers in the Jämtland county. Majority of homeowners (74%) contacted more than one external actor for information when they plan to replace their windows. Window sellers/installers have a strong influence on homeowners' window selection as 97% of homeowners bought the windows that were recommended to them. The sellers/installers recommended windows with a U-value in the range of 1.1 to 1.8 W/m^{2}K and cited that condensation and high cost are the major drawbacks of windows with a U-value < 1.2 W/m^{2}K.

Keywords: *Energy efficient windows, homeowners, sellers, installers, Sweden*

1. Introduction

Diffusion of energy efficient windows in Swedish building sector may reduce fossil fuel dependency and mitigate climate change. The thermal performance of windows in Sweden has improved over the years and the energy efficiency standard is higher than that of many other countries. For example, in Sweden a window is considered energy efficient if its U-value is ≤ 1.2 W/m^{2}K [1], while in Denmark the U-value for such windows is ≤ 1.8 W/m^{2}K [2].

About 85% of detached houses in Sweden are more than 30 years old [3], and windows in many of these buildings may be in poor condition. Moreover as these buildings were built before energy efficiency was emphasized in the building codes in 1977, a large market is available for energy efficient windows. A survey of owners of detached houses in Sweden revealed that homeowners are more likely to replace/change windows than other building envelope components [4]. Due to their long life span the type of windows installed will influence the energy use of the buildings for a long time. From primary energy saving perspective, it is important that homeowners adopt the most energy efficient windows available in the market.

Homeowners may not adopt energy efficiency measures because of lack of adequate and reliable information, lack of awareness [5, 6], or the inability to interpret the available information. Furthermore, potential adopters may have difficulties in perceiving the performance and advantages of energy efficiency measures if the gains are not directly visible [7], are insignificant or are delayed. In such situations homeowners' final choice of a particular measure is influenced by actors whom they consider as experts in the field. Homeowners' adoption of a particular type of window may depend on the recommendation of the sources important to homeowners. Window sellers/installers are the closest link to customers in the demand chain, and could exert a strong influence on consumer's choice. To the best of our knowledge, no e mpirical studies about influence of external actors on homeowners' adoption of energy efficient windows have been conducted in Sweden. In this paper, we analyse the role of external actors especially window sellers/installers in homeowners' adoption of energy efficient windows.

2. Role of external actors

Homeowners may seek information or advice because of uncertainties regarding information alternatives or due to uncertainties on which alternative to choose. For high investments, customers may search for information from various sources [8]. The degree to which customers' search for information depends on their perception of the costs associated with the search [8], or their ability and motivation [9]. Sources of information include mass media, interpersonal sources, sellers/installers and neutral sources like municipal energy advisers. Though mass media could improve consumers' awareness about various products their ability to influence consumers' adoption decision is limited to a small group of innovators and early adopters [10]. To reduce the burden of interpreting vast amount of information and to obtain appropriate information homeowners' may seek advice from expert(s) whom they think are credible. The external advice may help the potential consumer to clear their thoughts about the decision and improve their decision confidence [11]. Individuals give more weightage to advice while performing a difficult task compared to an easy one [12]. Hence the relevance of advice may be more pronounced in the adoption of investment intensive measures like windows.

Trustworthiness of a organization working without profit motive (e.g. state agents or non-governmental organizations) is higher than one working for profit motive (e.g. marketing agents) [10]. However, store sales personnel were found to influence customers' choice [13, 14]. Store visits and salespeople are very important source of information for buyers of durables [15, 16, 17], and individuals who are susceptible to interpersonal influence are more influenced by salespersons [18]. Studies in Sweden have shown that homeowners consider sellers/installers as an important source of information when adopting heating system [19], energy efficient building envelope components [4]. This may be because of homeowners' perception that the sellers/installers are experts in their respective field and/or they usually make house visits to make on the spot assessment of the requirements of their prospective clients. Moreover homeowners may consider the window sellers/installers in their locality similar to themselves, and the influence of an *expert* salesperson is high in such circumstances [20].

3. Methodology

The research methodology includes both quantitative and qualitative analysis.
Homeowners' perception of external actor's influence in the adoption decision is based on a mail-in questionnaire survey of homeowners who availed investment subsidy to replace their windows with energy efficient windows (U-value $\leq$ 1.2 W/m^{2}K). Questionnaire were sent to 1010 homeowners in the two neighbouring counties in central Sweden (315 in Jämtland and 695 in Västernorrland) whose addresses were collected from Boverket (Swedish National Board of Housing, Building and Planning) which administrated the programme during 2007-2008. On an average, the homeowners in our survey received 14% of their investment cost as subsidy. The survey was conducted during November – December 2009. 25 questionnaires were returned either due to incorrect address or non residence of the addressee. The response rate for the survey after one reminder was 59%. The questionnaire consisted of mainly three parts. Section A included questions about the reasons for replacement of windows, factors influencing respondents choice of windows, influence of external actors, perception towards energy efficiency measures. Questions regarding the influence of policy instruments in respondents' adoption of energy efficiency measures were covered in Section B. Section C included questions related to socio-economic variables.

To understand the supply side actors' perspective on energy efficient windows, we conducted interview of window sellers/installers in Jämtland county. A list of window sellers/installers in the Jämtland county was prepared based on a search on the yellow pages. All the 29 listed window sellers/installers/repairers were contacted for a semi structured interview. However some of them did not participate because they had discontinued their business or merged with other companies or did not have time or were just into window cleaning business, while three sellers/installers were not interested to participate. Accordingly, we interviewed 12 sellers/installers. The interviews were conducted during November 2009 – March 2010. We asked the interviewees mostly open ended questions about their influence on homeowners' choice of windows and their perception towards energy efficient windows.

The interviewed personnel were highly experienced in window business as nine persons had more than 25 years of experience, while two had more than 10 years of experience. Ten of the interviewees were owner or partner of their firm, while two were sales personnel of their organization.

4. Results

4.1. Respondents who availed investment subsidy to install energy efficient windows

79% and 19% of the sample (1010 homeowners) installed windows with U-value 1.2 W/m^{2}K and 1.1 W/m^{2}K, respectively, while the rest 2% installed windows with U-value less than 1.1 W/m^{2}K. The composition of the respondents according to age, education, household income, building age and duration of occupancy in their house is provided in Table 1. Respondents who were old, university educated and who lived in old houses were more likely to replace their windows with energy efficient windows.

Table 1: Composition of the respondents

Age group in years (N=574)	Education (N= 573)	Annual household income ('K SEK) (N= 563)	Building age in years (N=566)	Occupancy period (N=562)
≤ 35 - 9%	Primary - 28%	≤ 150 - 2%	≤ 20 - 1%	≤ 3 year - 15%
36-45 - 18%	Upper - 33% secondary	150 – 300 - 23%	21-30 - 3%	4-10 years - 21%
46-55 - 20%	University - 39%	300 – 450 - 24%	31-40 - 35%	11-20 years - 17%
56-65 - 23%		450 – 600 - 24%	41-50 - 21%	21-30 years - 15%
>65 - 30%		> 600 - 27%	>50 - 40%	31- 40 yeas - 20%
				>40 years - 12%

Note: Percentages are rounded to the nearest unit.

4.2. Information search and role of external actors

For most respondents' window sellers/installers (which include glass working companies) was the most influential actor in their window choice (Table 2). Interpersonal sources such as friends/peers/relatives were reported to be the second most influential external actors. Other external actors were important for only fewer respondents.

Table 2: Importance of external actors' advice in homeowners' choice of windows

Influence of external actor	% of respondents				
	N	Important	Neither nor	Not important	Mean
Window sellers/installers	489	56	22	22	3.51 (0.064)
Friends, relatives and peers	396	33	17	50	2.56 (0.079)
Window manufacturers	388	27	11	62	2.23 (0.080)
Internet forums	373	21	13	66	2.03 (0.075)
Carpenters	377	21	8	71	1.97 (0.077)
Building companies	378	18	8	74	1.83 (0.077)
Municipal energy advisers	363	14	6	80	1.63 (0.066)
Energy companies	345	1	4	95	1.15 (0.029)

N = Number of respondents in respective category. Mean values are based on homeowners' response on a Likert scale of 1 to 5 (1 = not at all important, 5 = very important). Values in parentheses are standard errors.

There was no significant relationship among respondents preference for information sources on windows and their demographic characteristics. However, there was a trend that suggests that respondents with different demographic characteristics accorded varying level of importance to the external actors (Table 3). For example, university educated or aged up to 45 years or female respondents gave higher importance to interpersonal sources.

Table 3: Respondents in different demographic groups who attributed greater importance to an information source compared to other groups of respondents

External actor	Respondents' socio-demographic characteristics			
	Gender	Education	Age	Annual household income (1000 SEK)
Window sellers/installers	Female	Basic	>45 years	
Friends, relatives and peers	Female	University	Upto 45 years	150-300
Window manufacturers			>65 years	
Internet forums		University	Upto 35 years	450-600
Carpenters			46-55 years	150-450
Building companies		Basic	>65 years	
Municipal energy advisers		Basic		

Majority of homeowners (74%) contacted more than one external actor for information when they plan to replace their windows. About 60% of homeowners contacted two or more different type of external actors for information. Majority of homeowners contacted window sellers/installers for information on windows, while energy advisers and energy companies were contacted by least number of homeowners (Table 4).

Table 4: Homeowners' frequency of contact to external actors for information about windows

External actor contacted by homeowners	N	% of respondents contacting a specific external actor		
		Contacted many	Contacted only one	Did not contact any
Window sellers/installers	519	47	37	16
Friends, relatives and peers	431	24	24	52
Window manufacturers	430	17	17	66
Building companies	438	10	18	72
Carpenters	427	5	23	72
Municipal energy advisers	418	2	14	84
Energy companies	410		1	99

N – Number of respondents; 5% of the respondents did not contact any of the above external actors.

26% of respondents bought and installed windows themselves, 21% bought windows themselves and installed it through professionals, and 53% replaced windows on *turnkey* basis wherein a professional did the entire window replacement. The homeowners who bought and installed windows themselves may be more knowledgeable in windows as they were more likely to be aware of better energy efficient windows in the Swedish market ($p \leq 0.01$ as per chi-square test) than those who replaced their windows through professionals. 69%, 18% and 11% of respondents entrusted the *turnkey* job to window sellers/installers, construction companies and carpenters, respectively. The various reasons homeowners' entrust the window replacement task to the professionals is given in Table 5.

Table 5: Reasons for entrusting the window replacement task on a turnkey basis

Reasons for entrusting the work on a *turnkey* basis	N	% of respondents		
		Agree	Neither nor	Disagree
The quality of the work would be high	274	85	4	11
It was time consuming to do it myself	251	84	5	11
It was complex to do it	263	75	9	16
Did not have the skill to install windows myself	281	67	10	23
Did not have the knowledge to select right window	272	43	14	43
It was the cheapest option	253	31	19	50
Friends, relative and peers recommended	241	20	10	70

The most important factors for selecting a particular vendor for window replacement was easiness to contact them and the company's reputation to undertake good quality work and service (Table 6).

Table 6: Reasons for selecting a particular vendor for turnkey replacement of windows

Reason for selecting a particular vendor	N	% of respondents		
		Agree	Neither nor	Disagree
It was easier to contact the company	242	69	16	15
Has the reputation of undertaking good quality work	239	65	23	12
Has the reputation of good service	240	63	25	12
Offered the best price	241	49	24	27
Have good experience of their past work	229	28	12	60
Friends, relative and peers recommended	223	22	13	65
Only one who could offer the manufacturer I wanted	220	18	14	68
Only company available locally	214	8	5	87

53% of the total respondents and 64% of those who entrusted the window replacement task on *turnkey* basis reported that the company from which they bought windows had recommended a specific window. About 97% of respondents had installed the windows that were recommended to them.

4.3. Window sellers/installers perspective

The window sellers/installers believed that they exert a very strong influence on their customer's choice of windows. Some of them stated that their suggestions/information had a very strong impact as often the customers were not aware about the choices.

"Normally they [homeowners] decide about the type of windows when I visit them".

"They [homeowners] have many questions, …generally the advice we give weighs heavily".

Window sellers/installers recommend/prefer windows with U-value from 1.1 to 1.8 W/m^2K (Table 7).

Table 7: U-value window sellers/installers prefer/recommend

U- value (W/m^2K)	Number of interviewees
1.1 -1.2	2
1.2	6
1.3	2
1.5	1
< 1.8	1

Majority of the sellers/installers do not recommend U-value less than 1.2 W/m^2K mostly due to condensation problem and high cost of such windows. Some of the interviewees on condensation stated:

" Below 1.2 [U-value] you can get problems with condensation…. There is a wild chase to reduce U-values…. But in reality it does'nt work…"

"Customers think it is too damn that they bought new windows and it gets condensation in the outside"

"…if you get down to 1.2,…, the risk of condensation is large and I think the requirement is too hard"

"If you get highly annoyed if you see a white window when you come down to eat breakfast in the kitchen, it was not nice of you to bought a low U-value window"

According to a couple of sellers/installers, it is difficult to *sell* the window manufacture's argument that the external condensation in windows indicates its high energy efficiency. As per four sellers/installers, condensation in external surface of energy efficient windows occurs only during a very few occasion in Jämtland. As per many sellers/installers if the homeowners were informed about the potential condensation problem then the homeowners will not be "surprised" by condensation and thereby would not be dissatisfied by it. Window sellers/installers usually inform their customers about condensation issue associated with energy efficient windows.

The price of windows with U-value < 1.2 W/m^2K was a concern for many of the interviewees. Eight sellers/installers reported that it was expensive to buy windows with U-value 1.0 W/m^2K, and energy efficiency benefits of such windows compared to windows with U-value of 1.2 W/m^2K was only marginal. Hence, according to window sellers/installers it is not worth to buy such windows.

5. Discussion and conclusion

Prior to window purchases, majority of homeowners approached multiple external actors for information. Hence, Swedish homeowners may undertake active pre-purchase information search before buying windows. This study shows that majority of homeowners' considered window sellers/installers as the most influential actor in their window choice. We found that the influence of window sellers/installers on homeowners was so strong that if window sellers/installers recommended a particular window, homeowners' usually would install it. Other external actors were not that influential. This indicates that window sellers/installers have a determinant role in the diffusion of energy efficient windows in Swedish detached houses Majority of homeowners in our sample (79%) who availed the investment subsidy for window replacement had installed windows that had a U-value of 1.2 W/m^2K. Their choice of

windows with U-value of 1.2 W/m^{2}K may be due to the favourable advice they received from window sellers/installers on such windows and that a U-value of 1.2 was required to receive the subsidy.

Window sellers/installers preferred a window that was "reasonably" energy efficient, and majority did not recommend windows with U-value <1.2 W/m^{2}K. They believed that the investment required for windows of U-value <1.2 W/m^{2}K is not economically justifiable and also such windows cause condensation problem. To convince homeowners about the cost benefits and condensation issues, the sources they rely most (viz., window sellers/installers) need to be confident on those issues. The adoption rate of higher energy efficient windows could be increased by addressing the concerns of window sellers/installers towards condensation issues and higher prices of such windows.

For a significant percentage of homeowners professionals did the entire window replacement. This is mainly because of respondents' perception that the quality of the work would be good or due to time constraints to install windows themselves. Window sellers/installers were the most preferred actor for installing windows on *turnkey* basis. The most common reasons reported for selecting a particular vendor was easiness to contact them and reputation to undertake good quality work and service. The price offered was reported by relatively less number of homeowners in selecting the vendor. This may be because owing to the competition there could be only small price difference similar windows sold by vendors.

Only 14% of respondents considered energy advisers as an important source of information on windows, and only 16% contacted an energy adviser. Our result is similar to earlier findings on homeowners contact with energy advisers [21]. The reasons could include low awareness about the energy advice service and a perception that energy advisers may not be experts in windows.

Our discussions on ho meowners' adoption decision are based on a mail-in questionnaire survey, and this has some disadvantages. For example, about 41% of the homeowners did not respond, and therefore, non-response bias might be a concern which we did not investigate. Furthermore, the respondents may not have entirely understood the questions, as in all questionnaire surveys, and we were not able to clarify the questions, which in turn might have influenced the responses. Similarly, as local climate may influence external condensation on windows, the perception of window sellers/installers on c ondensation in energy efficient windows and their subsequent recommendations may vary across Sweden.

Acknowledgments

The authors gratefully acknowledge the financial support from Swedish Energy Agency and from the European Union. We like to thank Kerstin Hemström for conducting the interviews.

References

[1] B. Kiss, Energy efficient window development – Historical overview of the development of energy efficient windows in Sweden, Energitinget, 11- 12 March, 2009, Stockholm.

[2] D. Avasoo, Energy transparency for energy efficiency. A Future buildings forum event - Cooling buildings in a warming climate, 21-22 June, 2004, Sophia Antipolis, France.

[3] SCB, Yearbook of Housing and Building Statistics 2009 (Bostads- och byggnadsstatistisk årsbok 2009), 2009, Statistics Sweden, Örebro, Sweden, ISSN 1654-0921

[4] G. Nair, L. Gustavsson, K. Mahapatra, Owners perception on adoption of building envelope energy efficiency measures in Swedish detached houses, Applied Energy, Applied Energy 87, 2010, pp 2411-2419.

[5] S. Birner, E. Martinot, Promoting energy-efficient products: GEF experience and lessons for market transformation in developing countries, Energy Policy 33, 2005, pp 1765–1779.

[6] S. Owens, L. Driffill, How to change attitudes and behaviours in the context of energy, Energy Policy 36, 2008, pp 4412–4418.

[7] M. Levine, D. Ürge-Vorsatz, K. Blok, L. Geng, D. Harvey, S. Lang, G. Levermore, M.A. Mehlwana, S. Mirasgedis, A. Novikova, J. Rilling, H. Yoshino, Residential and commercial buildings. In Climate Change: Mitigation. Contribution of Working Group III to the 4th Assessment Report of the IPCC, Cambridge University Press. NY, 2007.

[8] D.I. Hawkins, D.L. Mothersbaugh, R.J Best, Consumer Behavior: Building Marketing Strategy. McGraw Hill/Irwin, New York, 2007.

[9] J.R. Bettman, C.W. Park, Effects of prior knowledge and expereince and phase of the choice process on c onsumer decision processes: A protocol analysis, Journal of Consumer Research 7, 1980, pp 234-248.

[10] E.M. Rogers, Diffusion of Innovations. The Free Press, New York, 2003.

[11] F. Gino, D.A. Moore, Effects of task difficulty on use of advice, Journal of Behavioral Decision Making 20, 2007, pp 21–25.

[12] C. Heath, r. Gonzalez, Interaction with others increases decision confidence but not decision quality: evidence against information collection views of interactive decision making. Organizational Behavior and Human Decision Process 61, 1995, pp 305–326.

[13] R.W. Olshavsky, Consumer-Salesperson interaction in appliance retailing, Journal of Marketing Research 10, 1973, pp 208-212.

[14] B.G. Goff, J.S Boles, D.N Bellenger, C. Stojack, The influence of salesperson selling behaviors on customer satisfaction with products, Journal of Retailing 73, 1997, pp 171 - 183.

[15] A.L. Pennington, Customer-Salesman bargaining behavior in retail transactions, Journal of Marketing Research 5, 1968 pp 255-262.

[16] J.T. Rothe, L.M. Lamont, Purchase behavior and brand choice determinants for national and private brand major appliances, Journal of Retailing 49, 1973, pp 19-33.

[17] A.G. Woodside, J.T. Sims, Retail sales transactions and customer 'Purchase Pal' effects on buying behavior, Journal of Retailing 52, 1976, pp 57-64.

[18] T.Sun, Z.Tai, K-C, Tsai, The role of interdependent self-construal in consumers' susceptibility to retail salespersons' influence: A hierarchical approach, Journal of Retailing and Consumer Services 16, 2009, pp 360-366.

[19] K. Mahapatra, L. Gustavsson, An adopter-centric approach to analyze the diffusion patterns of innovative residential heating systems in Sweden, Energy Policy 36, 2008, pp 577–590.

[20] A.G. Woodside, J.W.Jr. Davenport, The effects of salesman similarity and expertise on consumer purchasing behavior, Journal of Marketing Research 11, 1974, pp 198-202.

[21] K. Mahapatra, G. Nair, L. Gustavsson, Energy advice service as perceived by Swedish homeowners, International Journal of Consumer Studies 35, 2011 pp 104-111.