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Original research article

The role of adoption norms and perceived product attributes in the adoption of Dutch electric vehicles and smart energy systems

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ABSTRACT

We studied to what extent perceived adoption norms affect the likelihood of adopting sustainable innovations, next to evaluations of the instrumental, environmental and symbolic attributes of these innovations. As hypothesised, results showed that people are more likely to adopt a sustainable innovation the more they evaluate the attributes of these sustainable innovations favourably and the more they think significant others would consider adoption (i.e., when adoption norms are strong). Moreover, we hypothesised and found that positive evaluations of the symbolic attributes are more likely to promote the adoption of sustainable innovations when people expect that few significant others would consider adoption. These findings suggest that weak adoption norms that are typical in the early adoption stage may both inhibit and promote adoption of sustainable innovations, via different routes.

1. Introduction

Various low-emission innovations have been introduced that can mitigate anthropogenic climate change. Examples are electric cars and smart energy systems. These sustainable innovations are still in the early adoption phase with low adoption rates. Encouraging their adoption is an important strategy to combat climate change. It is therefore highly relevant to understand which factors affect the likelihood of adopting sustainable innovations. According to the theory on diffusion of innovations, the adoption of innovations is a gradual process, and entails several stages preceding the actual acquisition or use of innovations [1,2], including acceptability of sustainable innovations, interest in sustainable innovations and intention to adopt sustainable innovations [3,4,1,2]. A recent study suggests that groups at different stages of the adoption of smart energy systems perceive different benefits and barriers of these systems [5]. It is therefore important to consider different indicators of adoption that reflect different steps in the adoption process. The theory on diffusion of innovations has mainly been employed to examine the process of diffusion of innovations and the characterization of adopter segments. Extending this research, our study focuses on drivers of adoption, and particularly the relationship between evaluations of attributes of the sustainable innovation and adoption norms on the one hand, and on the other hand interest in the sustainable innovation and intention to adopt the innovation.

According to the model of the impact of evaluations of Instrumental, Symbolic, and Environmental attributes on adoption of sustainable innovations (ISE-model, [3,4]), individual's evaluations of three types of attributes of sustainable innovations play a role in the adoption likelihood of sustainable innovations: instrumental, environmental and symbolic attributes. First, people's evaluations of instrumental attributes of sustainable innovations can influence the adoption likelihood of sustainable innovations. For instance, beliefs about the extent to which solar panels can accommodate one's energy needs affect the likelihood that one would adopt solar panels, while beliefs on the range of batteries can affect the adoption of electric vehicles. In general, instrumental attributes of sustainable innovations are evaluated somewhat negatively (e.g [6,7]). Such instrumental drawbacks (e.g. a limited driving range of electric cars) are likely to discourage adoption.

Second, people's evaluations of the environmental outcomes of adopting a sustainable innovation can affect adoption likelihood. Sustainable innovations typically have a lower environmental impact and thus have favourable environmental attributes, which is likely to enhance adoption.

Third, evaluations of the symbolic attributes of the innovation can affect adoption likelihood, reflecting the extent to which adoption is believed to signal one's identity or enhance one's status [3,8,9]. For instance, adopting sustainable products may enhance one's status [10]. Moreover, adopting an electric vehicle can signal that one is an

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innovative person or a caring person, which can encourage adoption as these are typically perceived to be positive characteristics [11].

Research has shown that evaluations of all three attribute types affect the likelihood that people adopt a sustainable innovation [3,4]. Interestingly, particularly positive evaluations of symbolic attributes appeared to be an important and consistent predictor of the likelihood of adopting various sustainable innovations [3,4,12,13]. Symbolic attributes can be particularly important for the adoption of sustainable innovations because sustainable innovations typically have some instrumental drawbacks, especially in the early introduction phase [3,4]. Notably, the adoption of sustainable innovations is likely to be more diagnostic of the personality of the adopter, and thus send a stronger signal, when such "discouraging factors" are present, increasing the importance of evaluations of the symbolic attributes in explaining adoption decisions. Indeed, attribution theory [14,15] and self-perception theory [16] suggest that people can use overt behavior to better understand themselves [16] and others [14,15]. According to attribution theory, observed behavior can be attributed to internal factors, such as personal characteristics, or external factors, such as positive instrumental attributes. A person is more likely to attribute a behavior to personal characteristics of the actor (and less to external factors) when external factors are likely to discourage the behavior. For example, if you drive an electric vehicle despite its limited driving range, you apparently do not drive an electric vehicle because it is convenient (i.e., an external factor), but because you are a person who truly wants to do so (i.e., an internal factor). Such attributions can be made by others as well as by oneself. People may be sensitive to attributions made on the basis of their behavior [17], which suggests that they may be motivated to engage in behavior that is likely to lead to favorable attributions and avoid behavior that may lead to unfavorable attributions. For example, people may anticipate that adoption of sustainable innovations with some instrumental drawbacks strongly signals what type of person they are. As a result, positive evaluations of symbolic attributes may more strongly affect the likelihood of adopting sustainable innovations. There is some initial empirical evidence that supports this reasoning. Notably, evaluations of symbolic attributes appeared to be more predictive of the likelihood of adopting sustainable innovations when people perceived the sustainable innovations to have some instrumental drawbacks [3,4].

Another factor that may affect the adoption of sustainable innovations is the number of people that are expected to consider adoption of the innovation. Specifically, beliefs about the likelihood that significant others (i.e., people that are important to you; cf. [18,19]) would use or consider using sustainable innovations may influence one's own intention to use sustainable innovations. SNotably, particularly in the early introduction phase, very few people own or use a sustainable innovation. Hence, in the early introduction phase, it is highly unlikely that significant others own or use the sustainable innovation, or even intend or consider to purchase and use the sustainable innovation. This implies that adoption norms, which we define as perceptions of the extent to which significant others will adopt or consider adopting a sustainable innovation in the near future, are probably weak. Please note that adoption norms are different from descriptive norms [20], as descriptive norms are defined as perceptions of the extent to which others adopted a sustainable innovation, while adoption norms reflect perceptions of the extent to which others *intend or consider* to adopt the sustainable innovation. Adoption norms may therefore be particularly relevant in situations where people may consider adoption, but where only few have actually adopted the innovation, as is the case in the early introduction phase of sustainable innovations. Adoption norms also differ from injunctive norms [20] as injunctive norms that entail an individual's beliefs about what others approve of.

Research on social norms suggests that the perceived behavior and expectations of others, especially of people who are important to us, guide our own behavior ([19–21,32]). Social norms can also affect the adoption of sustainable innovations. Indeed, a Swedish study revealed that adoption of solar panels was more likely when people thought their peers adopted solar panels. It was argued that a stronger descriptive norm provided people with some assurance that installing solar panels is not a major hassle [22]. Similarly, while strong adoption norms promote adoption, weak adoption norms can serve as a cue that adoption is not adaptive in the given situation; if significant others are not considering adoption of the sustainable innovation, it is probably not a sensible thing to do (cf [20].). This suggests that at the early introduction stage, weak adoption norms are likely to reduce the likelihood that individuals consider adopting a sustainable innovation.

Extending previous research, we reason that weak adoption norms may affect the adoption of sustainable innovations in an indirect way as well, by strengthening the relationship between the evaluation of symbolic attributes and adoption likelihood. Similar to instrumental drawbacks, adoption is more likely to be attributed to personal characteristics when adoption norms are weak, as this is likely to signal that there are seemingly no clear external factors encouraging adoption (cf. [14]). As indicated above, in the early introduction phase, adoption norms are typically weak, making it more likely that adoption signals one's identity to others and to the self. People may (unconsciously) anticipate such internal attributions of adoption, and as a result, evaluations of symbolic attributes may be more likely to affect adoption of sustainable innovations when adoption norms are weak. This implies that in the early introduction phase of innovations, weak adoption norms may not only inhibit adoption (i.e., a direct effect of adoption norms on adoption likelihood), but may also increase adoption likelihood by strengthening the relationship between evaluations of the symbolic attributes and the likelihood that individuals adopt sustainable innovations (i.e., indirect effect of adoption norms).

1.1. Current study

This paper aims to test our novel reasoning on how adoption norms can affect the adoption of sustainable innovations. More specifically, we test an extended ISE-model and hypothesize that adoption norms are related to the likelihood of the adoption of sustainable innovations, even when controlling for the effect of evaluations of the instrumental, environmental and symbolic attributes of sustainable innovations (hypothesis 1). We conceptualize adoption norms as beliefs on how many significant others consider or intend to adopt a sustainable innovation. Importantly, we not only test the direct effect of adoption norms, but additionally test whether the interaction between symbolic attributes and adoption norms affects the likelihood of adopting a sustainable innovation (See Fig. 1). We expect that the evaluations of symbolic attributes are more strongly related to the likelihood that individuals adopt a sustainable innovation when people believe that few significant others would consider adopting the sustainable innovation, and thus when adoption norms are weak (hypothesis 2).

We tested our model and hypotheses in two questionnaire studies, focusing on the adoption of two different sustainable innovations. The first study examined the likelihood of adopting a smart energy system

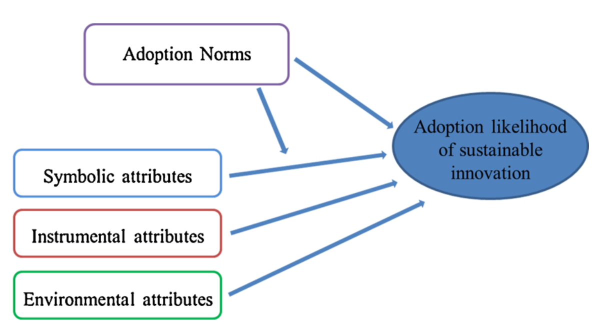

Fig. 1. Extended ISE-model.

that was going to be offered to inhabitants of a neighbourhood in the near future. Study 2 examined the likelihood of adopting an electric car.

2. Study 1: adoption of smart energy systems

Study 1 aimed to test the extended ISE-model and investigated whether adoption norms affect the likelihood of adopting smart energy systems, in addition to individuals' evaluation of the instrumental, symbolic and environmental attributes of a smart energy system. This study was part of a field trial that aimed to test smart energy systems among home owners who had installed rooftop solar panels in a neighborhood in Amersfoort, a middle-sized city in the Netherlands. We report data from a questionnaire study conducted among potential participants of the smart energy system project before the actual start of this project. The smart energy system being to be tested included technologies to monitor energy and gas use and energy production of one's solar panels via smart meters and smart plugs. Users would be provided with feedback on their energy and gas use as well as energy production via an app that could be installed on laptops, smart phones, and tablets. Users also would receive detailed feedback on how much energy is consumed by using particular devices, and thus would learn how much energy can be saved by using them less. Also, the feedback would reveal how well one's own energy production matches one's own energy demand at a given time, which could enable and motivate users to optimize the use of self-generated renewable energy.

2.1. Method

2.1.1. Participants and procedure

Before the announcement and start of the smart energy system project, late 2012, a questionnaire study was conducted among a random sample of the target group of the project[1] . Three hundred questionnaires were distributed door-to-door. The questionnaire contained a brief description of the smart energy system that would later be introduced in the neighborhood, which stated that smart energy systems provide users with feedback on one's energy use and energy production on the basis of smart metering data. We indicated that the feedback was aimed to facilitate users to lower their energy use and to optimally use their own produced solar energy by shifting energy use in time. In total 119 questionnaires (40% response) were recollected upon appointment. Three months later, early 2013, project participants were recruited. Project participants who had not filled out the questionnaire late 2012 were asked to fill out the same questionnaire as soon as they indicated to be willing to participate in the project. This resulted in 76 additional respondents (see also the method section of Noppers et al. [33]). Hence, the total sample comprised of 195 respondents. The mean age of the respondents was 46 (SD = 10.97); 127 respondents were male, 66 were female, while 2 respondents did not specify their gender. Compared to the Dutch population, our sample included a higher proportion of middle-aged people (about half of the sample was between age 36 and 55 years old), and a higher proportion of people with a higher education level (see Table 1).

2.1.2. Measures

Respondents were asked to indicate to what extent they evaluated 6 instrumental, 3 environmental, and 4 symbolic attributes of smart energy systems negatively or positively, on a scale ranging from -5 to 5, with 0 meaning neither negative nor positive (see Table 2 for the items). Items were selected from prior studies on adoption of sustainable products [3,4,23,24]. When appropriate, responses were reverse coded so that higher scores indicated more positive evaluations of the three attributes. We computed mean scores of the items reflecting the three attributes. On average, respondents were slightly positive about the instrumental attributes (M = 0.87, SD = 1.23, Cronbach's α = .72) and symbolic attributes of smart energy systems (M = 0.91, SD = 1.38, Cronbach's α = .79), while they were most positive about the environmental attributes of smart energy systems (M = 2.55, SD = 1.37, Cronbach's α = .77).

We measured adoption norms by asking respondents what percentage of significant others they thought would use smart energy systems in the near future. Responses were given on a 7-point scale: 1: "0%", 2:"15%, 3: "30%", 4: "45%", 5:"60%", 6:"75%", 7: "90%". On average, respondents expected that between 30% and 45% of significant others would use smart energy systems in the near future (M = 3.73, SD = 1.38).

Interest in smart energy systems was measured with 2 items. Respondents indicated to what extent they agreed with the statements "I am interested in smart energy systems" and "I would like to get more information about smart energy systems". Responses were given on a 7-point scale, ranging from "totally disagree" to "totally agree". Mean scores on both items were computed (M = 4.57, SD = 1.43, r = .55).

The intention to use smart energy systems was measured with the statement "I intend to use smart energy systems". Responses were given on a 7-point scale, ranging from "totally disagree" to "totally agree" (M = 5.20, SD = 1.42). On average, intentions to use smart energy systems were rather strong.

Table 1
Socio demographics of the sample and the Dutch population in general.

	Sample	Dutch population[a]
Gender (male)	65%	50%
Age		
19–25	3%	8%
26–35	11%	16%
36–45	35%	19%
46–55	32%	20%
56–65	9%	17%
65 and older	8%	20%
Unknown	3%	
Education		
primary or lower	1%	5%
secondary and vocational	50%	60%
college and university	49%	34%

[a] Source: CBS [34].

2.2. Results

2.2.1. Bivariate relationships between adoption norms, the evaluation of instrumental, symbolic and environmental attributes of smart energy systems, and likelihood of adoption of a smart energy system

Table 3 shows that, as expected, stronger adoption norms were associated with stronger interest in and intentions to use smart energy systems. More positive evaluations of the three attributes of smart energy systems were also associated with stronger intentions to use smart energy systems, and with a stronger interest in smart energy systems, although the evaluation of environmental attributes was not significantly related to interest in smart energy systems. A more positively evaluation of the attributes of smart energy systems was associated with believing that more significant others would use smart energy systems. Furthermore, evaluations of the different attributes of smart energy systems correlated moderately positively.

[1] Other part of the data has been published in Noppers, Keizer, Milovanovic and Steg (2016). Different from Noppers et al. (2016), the current study focused on the role of adoption norms in the adoption likelihood of sustainable innovations. In addition, the current study included *interest in* and *intention to use a smart energy system* as dependent variables, while the dependent variable reported in Noppers et al. (2016) was actual adoption of the smart energy system.

Table 2
Measures of evaluations of instrumental attributes, environmental attributes, symbolic attributes, adoption norm, interest in smart energy systems and intention to use smart energy systems.

	M (SD)
Instrumental attributes(Cronbach's α = .72)	.87 (1.23)
Smart energy systems will cause: less power outages (-5) – more power outages (5) [R]	
Using smart energy systems will cost me: less time and effort (-5) – more time and effort (5) [R]	
Smart energy systems will: save me money (-5) – cost me money (5) [R]	
Smart energy systems will be: less likely to provide the energy I need (-5) – more likely to provide the energy I need (5)	
Using smart energy systems will make my daily life: less comfortable (-5) – more comforTable (5)	
Smart energy systems give me: less control over my energy use (-5) – more control over my energy use (5)	
Environmental attributes (Cronbach's α = .77)	2.55 (1.37)
By using smart energy systems CO_2 emissions will: decrease (-5) - increase (5) [R]	
By using smart energy systems environmental problems like global warming will: decrease (-5) - increase (5) [R]	
By using smart energy systems the quality of the environment will: deteriorate (-5) – improve (5)	
Symbolic attributes (Cronbach's α = .79)	.91 (1.38)
Smart energy systems fit with how I want to see myself: totally disagree (-5) – totally agree (5)	
I can show who I am by using smart energy systems: totally disagree (-5) – totally agree (5)	
I can distinguish myself from others by using smart energy systems: totally disagree (-5) – totally agree (5)	
The use of smart energy systems says something: negative about me (-5) – positive about me (5)	
Adoption norms	3.73 (1.38)
According to you, what percentage of significant others is going to use smart energy systems in the near future?	
Interest (r = .55)	4.57 (1.43)
I am interested in smart energy systems	
I would like to get more information about smart energy systems	
Intentions to use smart energy systems	5.20 (1.42)
I intend to use smart energy systems	

[R]reverse coded for analyses.

Table 3
Bivariate correlations between adoption norms, evaluations of instrumental, symbolic and environmental attributes, and adoption likelihood of smart energy systems[a].

	Adoption norms	Evaluation instrumental attributes	Evaluation environmental attributes	Evaluation symbolic attributes	Interest in smart energy system
Evaluation instrumental attributes	.28**				
Evaluation environmental attributes	.18*	.32**			
Evaluation symbolic attributes	.21**	.30**	.27**		
Interest in smart energy system	.32**	.17*	.10	.35**	
Intention of using smart energy system	.31**	.26**	.16*	.38**	.70**

* $p < .05$.
** $p < .01$.
[a] Number of participants included to assess bivariate correlation varies from 183 to 195 due to missing values.

Table 4
Regression of interest in and intention to use smart energy systems on evaluations of the instrumental, environmental and symbolic attributes of a smart energy system, adoption norms, and the interaction between the evaluation of symbolic attributes and adoption norms.

	R^2	F	df[a]	β	t	p
DV: Interest in smart energy systems	.22	9.75	5,177			< .001
Evaluation of instrumental attributes				.10	1.32	.188
Evaluation of environmental attributes				−.07	−0.92	.365
Evaluation of symbolic attributes				.35	4.58	< .001
Adoption norms				.22	3.23	.001
Interaction symbolic attributes and adoption norms				−.14	−1.97	.050
DV: Intention to use smart energy systems	.24	11.19	5,177			< .001
Evaluation of instrumental attributes				.14	1.76	.080
Evaluation of environmental attributes				−.04	−0.55	.583
Evaluation of symbolic attributes				.39	5.15	< .001
Adoption norms				.18	2.68	.008
Interaction symbolic attributes and adoption norms				−.13	−2.08	.039

[a] Some respondents did not fill out all items of a particular scale and were excluded from the relevant analysis.

2.2.2. Testing the extended ISE-model

Next, we tested our conceptual model via regression analyses. The model explained 22% of the variance in interest in smart energy systems. Results showed that stronger adoption norms were associated with a higher interest in smart energy systems (see Table 4). Moreover, a more positive evaluation of the symbolic attributes of smart energy systems was associated with a stronger interest in smart energy systems. Evaluations of the instrumental attributes and the environmental attributes were not significantly related to interest in smart energy systems when the other variables were controlled for. More importantly, as

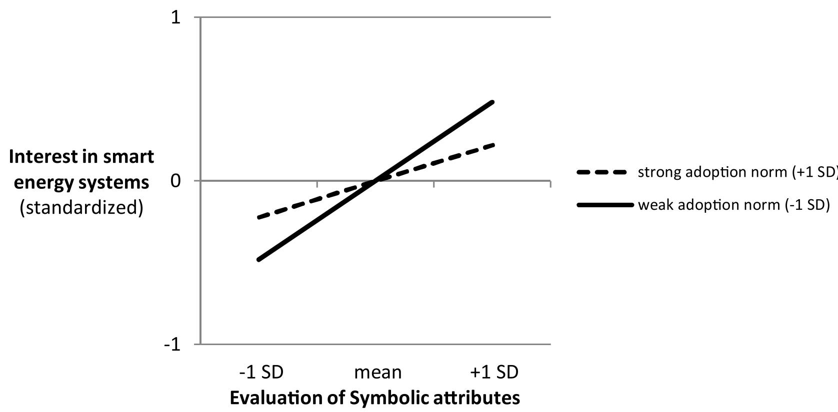

Fig. 2. Relationship between evaluations of symbolic attributes and interest in smart energy systems for respondents with weak and strong adoption norms.

expected, the evaluation of the symbolic attributes was more strongly related to interest in smart energy systems when adoption norms were weak. Via simple slopes analysis (following [25]), we investigated whether the relationship between evaluations of symbolic attributes and interest in smart energy systems differed for different levels of adoption norms. The “weak adoption norm” group represents the mean adoption norm minus one standard deviation. This corresponded with the belief that approximately 15% of significant others would use smart energy systems in the near future. The “strong adoption norm” group represents the mean adoption norm plus one standard deviation, corresponding with the belief that approximately 60% of significant others would use smart energy systems in the near future. The simple slopes analysis revealed that the relationship between the evaluation of symbolic attributes and interest in smart energy systems was stronger when respondents expected that relatively few significant others would use smart energy systems in the near future ($\beta = .48$, $t(182) = 4.19$, $p < .001$, 95% CI [0.26, 0.71]), compared to when they expected relatively many significant others to use smart energy systems in the near future ($\beta = .22$, $t(182)$, $p = .015$, 95% CI [0.04, 0.39]) (see Fig. 2).

Second, our model explained 24% of the variance in intention to use smart energy systems. As expected, stronger adoption norms were associated with a stronger intention to use smart energy systems (see Table 4). Furthermore, a more positively evaluation of the symbolic attributes of smart energy systems was associated with a stronger intention to use smart energy systems. More positive evaluations of instrumental attributes were only weakly related to stronger intentions to use smart energy systems, with a significance level of $p = .080$, while evaluations of the environmental attributes were not significantly related to intention to use smart energy systems when the other variables were controlled for (see Table 4). Importantly, we again found the expected interaction effect. More specifically, again, simple slope analysis revealed that the relationship between evaluations of symbolic attributes and intention to use smart energy systems was stronger when adoption norms were relatively weak (see Fig. 3). Hence, evaluations of the symbolic attributes of smart energy systems were more strongly related to intentions to use smart energy systems when respondents expected that relatively few significant others would use the sustainable innovation in the near future ($\beta = .52$, $t(182) = 4.66$, $p < .001$, 95% CI [0.30, 0.74]), compared to when they believed that relatively many significant other would use smart energy systems in the near future ($\beta = .26$, $t(182) = 3.16$, $p = .002$, 95% CI [0.10, 0.43]).

2.2.3. *Discussion*

The bivariate correlations showed that adoption norms and evaluations of the three attributes of smart energy systems were all positively and significantly related to interest in and intention to use smart energy systems, supporting Hypothesis 1. Yet, only adoption norms and evaluations of symbolic attributes were significantly and uniquely related to interest in and intention to adopt smart energy systems. This implies that people are particularly more likely to adopt smart energy systems when they expect that significant others will use smart energy systems in the near future, and when they evaluate the symbolic attributes of smart energy systems more positively. More importantly, in line with our theorizing, adoption norms affected the likelihood of adopting smart energy systems also in an indirect way. Specifically, as expected, evaluations of the symbolic attributes of smart energy systems were more strongly related to interest in and intention to adopt smart energy systems when people expected fewer significant others to use smart energy systems in the near future (i.e., when adoption norms were weak), confirming Hypothesis 2. This suggests that weak adoption norms, which are likely in the early introduction phase of sustainable innovations, are not only associated with a lower adoption likelihood, but can also increase adoption likelihood by enhancing the relationship between positive evaluations of the symbolic attributes and adoption

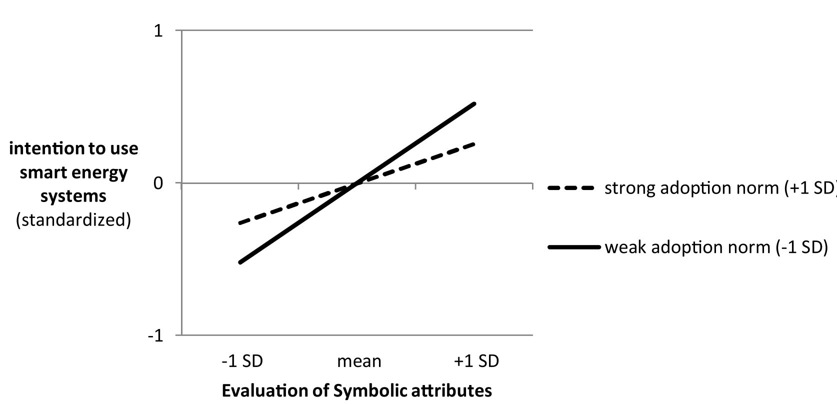

Fig. 3. Relationship between evaluations of symbolic attributes and intentions to use smart energy systems for respondents with weak and strong adoption norms.

likelihood. However, on average the inhibiting force induced by weak (er) adoption norms (i.e. the direct relationship with adoption norms) seemed to be larger than its indirect relationship via strengthening the relationship between evaluations of symbolic attributes and adoption likelihood.

3. Study 2: electric cars

Study 2 aims to test whether the extended ISE-model can explain the likelihood of adopting a different sustainable innovation: an electric car.

3.1. Method

3.1.1. Respondents and procedure

Respondents were residents of a city in the north of the Netherlands[2] . Households were randomly selected from two neighborhoods, one with predominantly social housing and the other with predominantly privately owned houses to ensure variance in social economic status in the sample. Questionnaires were filled out by respondents at their convenience, and recollected at a later time upon appointment. In total, 105 people (approximately 60% of the people contacted) completed the questionnaire; 53% was male (see Table 5), and the mean age was 45 (SD = 13.0). The level of education of the sample was higher and the level of income of the sample was slightly higher than the Dutch average [26], but both appeared to be comparable to that of Dutch car owners [27].

3.1.2. Measures

Respondents were asked to indicate to what extent they agreed that a typical full electric car had 22 instrumental, environmental and symbolic attributes (see Table 6 for the items, adapted from [8,28]; [35] [29]). Responses were given on a 6-point scale, varying from "totally disagree" to "totally agree". We included 11 instrumental attributes, 8 symbolic attributes, and 3 environmental attributes; mean scores were computed of the items that were selected to reflect the same attribute. On average, the instrumental attributes of an electric car were evaluated slightly positively (M = 3.68, SD = .82, Cronbach's α = .83), the environmental attributes were evaluated positively (M = 5.16, SD = 1.01, Cronbach's α = .79), while the symbolic attributes were evaluated somewhat negatively (M = 2.73, SD = 1.10, Cronbach's α = .90).

We measured adoption norms by asking respondents how likely it is that significant others would consider an electric car in their next car purchase (see Table 6). Answers were given on an 11-point scale varying from 0: "0% - not likely at all", 1: "10%", 2:" 20%" and so on to 10: "100% - definitely" (M = 3.26; SD = 2.39).

We again included two indicators of likelihood of adopting an electric car: interest in an electric car and intentions to buy an electric car. Interest in an electric car was measured with the statement "I am interested in an electric car"; responses could range from 1 "totally disagree" to 6 "totally agree" (M = 3.06, SD = 1.51). Intention to purchase an electric car was measured with 2 items. First, respondents indicated how likely it is that they would consider an electric car in their next car purchase, on a 11-point scale ranging from 0: "0% - not likely at all", 1: "10%", 2:" 20%" and so on to 10: "100% - definitely". Second, respondents indicated to what extent they agreed with the statement "I will never adopt an electric car"; scores could range from 1 "totally disagree" to 6 "totally agree". Responses to this last item were reverse-coded, so that higher scores reflected a stronger intention to buy an electric car. We standardized the scores on both intention items and computed mean scores to reflect intention to buy an electric car (r = .47).

[2] Other parts of the dataset has been published in Noppers et al. [3]. Different from Noppers et al. [3], the current study focuses on the effect of adoption norms on the adoption likelihood of sustainable innovations.

Table 5
Socio demographics sample and the Dutch population in general.

	Sample	Dutch population[a]
Gender (male)	53%	50%
Age		
19–25	6%	8%
26–35	20%	16%
36–45	22%	19%
46–55	29%	20%
56–65	20%	17%
65 and older	4%	20%
Education		
primary or lower	5%	5%
secondary and vocational	27%	60%
college and university	68%	34%

[a] Source: [26].

Table 6
Items reflecting instrumental attributes, environmental attributes, symbolic attributes, adoption norms, interest in electric cars and intention to purchase an electric car.

	M (SD)
Instrumental attributes (Cronbach's α = .83)	3.68 (.82)
An electric car is comfortable	
The purchase of an electric car is affordable	
An electric car accelerates well	
The use of an electric car is affordable	
An electric car is safe	
An electric car offers the driver flexibility	
An electric car can drive long distances without interruptions	
An electric car is reliable	
An electric car is spacious	
An electric car makes little noise	
An electric car can be charged quickly	
Environmental attributes (Cronbach's α = .79)	5.16 (1.01)
An electric car is environmentally friendly	
An electric car emits few particulates	
An electric car emits few greenhouse gases	
Symbolic attributes (Cronbach's α = .90)	2.73 (1.10)
An electric car enhances my social status	
An electric car fits with what I find important in life	
An electric car shows who I am	
An electric car fits with my view on life	
An electric car makes a personal statement	
An electric car enables me to distinguish myself from others	
An electric car fits with how I want to see myself	
An electric car gives me a sense of authority	
Adoption norms	3.26 (2.39)
How likely is it that significant others would consider buying an electric car in their next car purchase	
Interest	3.06 (1.51)
I am interested in an electric car	
Intention to buy an electric car (Scores wer standardized, r = .47)	.00 (1.00)
How likely is it that you would consider buying an electric car in your next car purchase	
I will never adopt an electric car (R)	

R: scores were reverse coded.

3.2. Results

3.2.1. Bivariate relationships between adoption norms, evaluations of instrumental, symbolic and environmental attributes, and likelihood of adopting an electric car

Table 7 shows that the stronger the adoption norms, the higher the interest in and intention to buy an electric car. Also, the more positively people evaluated the environmental and symbolic attributes of electric

Table 7
Bivariate correlations between adoption norms, evaluations of instrumental, symbolic and environmental attributes, and interest in and intention to buy an electric car[a].

	Adoption norms	Evaluation instrumental attributes	Evaluation environmental attributes	Evaluation symbolic attributes	Interest in electric car
Evaluation instrumental attributes	.17				
Evaluation environmental attributes	.29**	.37**			
Evaluation symbolic attributes	.28**	.21*	.31**		
Interest in electric car	.57**	.01	.27**	.29**	
Intention to buy an electric car	.67**	.25*	.40**	.45**	.69**

* $p < .05$.
** $p < .01$.
[a] Number of respondents included to assess bivariate correlation varies from 93 and 104 due to missing values.

cars, the more likely it was that they were interested in and intended to adopt an electric car. Most predictor variables were also (moderately) positively correlated with each other. The more positive the evaluations of the environmental attributes and symbolic attributes, the more likely it is that people expect significant others to consider an electric car in their next car purchase. Also, stronger interest in electric cars was associated with a stronger intention to adopt an electric car. Evaluations of the instrumental attributes correlated positively with evaluations of the other attributes and with intention to buy an electric car, but not with interest in an electric car and adoption norms.

3.2.2. Testing the extended ISE-model

The extended ISE-model explained 42% of the variance in interest in an electric car (see Table 8). As expected, stronger adoption norms were associated with a higher interest in an electric car. The evaluations of the three attributes were not uniquely related to interest in an electric car. Yet, as expected, evaluations of symbolic attributes were more strongly related to interest in electric cars when people expect that fewer significant others would consider adopting an electric car. More specifically, via simple slopes analysis [25], we investigated whether the relationship between the evaluation of symbolic attributes and interest in smart energy systems differed for different levels of adoption norm. The "weak adoption norm" group represented the mean adoption norm minus one standard deviation. This corresponded with the belief that approximately 9% of significant others would consider buying an electric car. The "strong adoption norm" group represented the mean adoption norm plus one standard deviation, corresponding with the belief that approximately 57% of significant others would consider buying an electric car. The simple slopes analysis revealed that more positive evaluations of the symbolic attributes of an electric car were significantly associated with stronger interest in electric cars when respondents believed that few others would consider purchasing an electric car (β = .32, $t(89)$ = 2.70, p = .008, 95% CI [0.08, 0.55]), while the symbolic attributes were not significantly associated with interest in electric cars when respondents believed that relatively many significant others would consider to purchase an electric car (β = -.16, t (89) = n.s., 95% CI [-.45, 0.13]; see Fig. 4).

The extended ISE-model explained 54% of the variance in intentions to purchase an electric car. Table 8 shows that stronger adoption norms, and to a lesser extent, more positive evaluations of the symbolic and environmental attributes were associated with a stronger intention to buy an electric car. However, the evaluations of the instrumental attributes and the interaction between adoption norms and evaluations of symbolic attributes were not significantly related to intentions to buy an electric car when the other variables were controlled for.

3.2.3. Discussion

Study 2 showed that adoption norms and evaluations of most of the attributes of electric cars were positively correlated to the likelihood of adopting an electric car, supporting Hypothesis 1. The extended ISE-model explained a considerable amount of the variance in interest in and intention to adopt electric cars. Adoption norms were most strongly associated with adoption likelihood: when respondents expect that not many significant others would consider buying an electric car in their next car purchase, they are less likely to adopt an electric car. Evaluations of symbolic attributes and environmental attributes significantly contributed to explaining intentions to adopt electric cars, but did not uniquely contribute to the explanation of interest in electric cars. More importantly, as expected, evaluations of the symbolic attributes of electric cars were more strongly related to interest in an electric car when people expected fewer significant others to consider adopting an electric car in the near future, providing partial support for Hypothesis 2. Yet, we did not find this interaction effect when explaining intentions to purchase an electric car.

Table 8
Regression of interest in and intention to adopt an electric car on evaluations of the instrumental, environmental and symbolic attributes of electric cars, adoption norms, and the interaction between the evaluation of symbolic attributes and adoption norms.

	R^2	F	df	β	t	p
DV: Interest in electric car	.42	12.25	5,84			< .001
Evaluation of instrumental attributes				−.16	−1.85	.068
Evaluation of environmental attributes				.13	1.43	.157
Evaluation of symbolic attributes				.06	0.63	.531
Adoption norms				.52	5.65	< .001
Interaction symbolic attributes and adoption norms				−.25	−2.66	.009
DV: Intention to buy an electric car	.54	20.12	5,86			< .001
Evaluation of instrumental attributes				.05	0.64	.521
Evaluation of environmental attributes				.16	1.97	.052
Evaluation of symbolic attributes				.23	2.84	.006
Adoption norms				.54	6.80	< .001
Interaction symbolic attributes and adoption norms				−.01	−0.03	.977

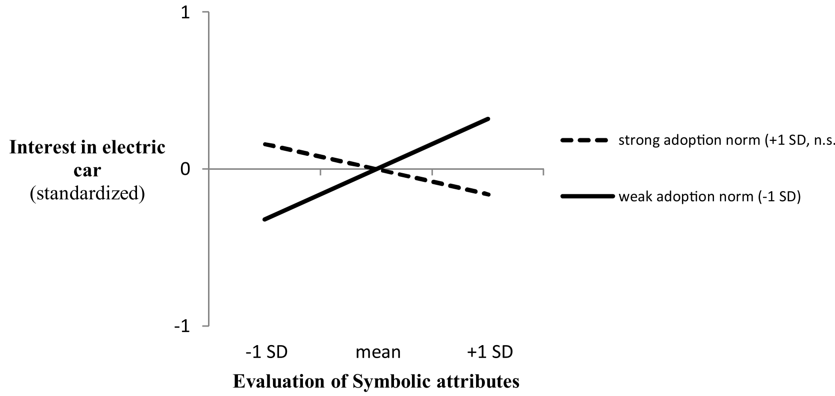

Fig. 4. Relationship between evaluations of symbolic attributes and interest in electric cars for weak and strong adoption norms.

4. General discussion

4.1. Main findings, theoretical implications and future research directions

The aim of this research was to examine the relationship between adoption norms, evaluations of instrumental, symbolic, and environmental attributes of sustainable innovations and the adoption of sustainable innovations. More specifically, we proposed and tested the extended ISE-model, investigating how adoption norms affect the likelihood of the adoption of sustainable innovations, in addition to the evaluations of the instrumental, environmental and symbolic attributes of sustainable innovations. Extending previous research, we further tested whether adoption norms may also indirectly affect adoption likelihood, by examining whether the relationship between evaluations of the symbolic attributes and the likelihood of adopting a sustainable innovation is stronger when adoption norms are weak.

First, as hypothesized, both studies revealed that the more people believed that significant others would consider adopting or using a sustainable innovation in the near future, the more likely they were to adopt the sustainable innovation themselves. This suggests that stronger adoption norms generally seem to enhance the adoption of sustainable innovations. This implies that adoption norms indeed affect behavior in a similar way as descriptive norms (e.g. [20]). This suggests that both expectations about intentions and actual behavior of significant others are likely to serve as a cue of whether behavior, such as adoption of sustainable innovations, is adaptive: when significant others are expected to consider adopting a sustainable innovation, adopting the sustainable innovation is probably sensible for me as well. This may explain why we found that people who evaluated the three types of attributes of sustainable innovations more positively also more strongly believed that significant others would consider adopting the sustainable innovation in the near feature. Interestingly, adoption norms appeared to be more strongly related to adoption likelihood than the evaluations of the three attributes in the extended ISE-model.

Evaluations of the instrumental, environmental and symbolic attributes were in most instances positively correlated with the indicators of adoption likelihood of both smart energy systems and electric cars. Similar to previous studies, evaluations of the symbolic attributes appeared to be most strongly related to adoption likelihood, and mostly appeared to be the only attribute that was uniquely related to interest in and intention to adopt the sustainable innovations when adoption norms and the evaluations of the other attributes were controlled for, except for interest in electric cars. Evaluations of the instrumental and environmental attributes were not strongly and uniquely related to adoption likelihood when we tested the full extended ISE-model, which could be due to the finding that adoption norms and evaluations of these attributes were correlated.

Importantly, in line with our second hypothesis, results of both studies suggest that adoption norms may not only affect adoption likelihood directly, but also indirectly, by affecting the extent to which evaluations of symbolic attributes are related to adoption likelihood. As expected, symbolic attributes were more strongly related to interest in and intention to use smart energy systems and interest in electric cars (but not to intentions to buy electric cars) when people believed that only few significant others would consider adopting these sustainable innovations in the near future. These findings support our theorizing that weak adoption norms increase the likelihood that adoption of sustainable innovations is attributed to personal characteristics rather than to external factors, which enhances the signaling function and thus the symbolic value of adopting a sustainable innovation, as reflected in stronger relationships between evaluations of symbolic attributes and indicators of adoption likelihood. As such, our findings provide first empirical support for the suggested novel route via which adoption norms affect behavior. These findings can be explained on the basis of attribution theory and self-perception theory that propose that internal attributions are more likely when there are no clear external reasons to adopt a sustainable innovation. Our findings suggest that people anticipate such attributions when considering the adoption of sustainable innovations, which may encourage the adoption of sustainable innovations with positive symbolic attributes. Our findings further extend research on social norms, including descriptive norms, as we found that weaker adoption norms can also increase interest in and intention to adopt sustainable innovations, by strengthening the relationship between evaluations of symbolic attributes and the likelihood of adopting sustainable innovations.

As such, our findings suggest that weak adoption norms can both inhibit and enhance adoption likelihood, albeit via different processes. The likelihood of adopting a sustainable innovation is probably the sum of both forces. The exact ratio between both forces can differ from person to person. Yet, on average the inhibiting force induced by weak(er) adoption norms (i.e. the direct effect) seems to be larger than the encouraging effect via strengthening the relationship between evaluations of symbolic attributes and adoption likelihood (i.e. the indirect effect). Future studies could examine the processes through which adoption norms affect the strength of the relationship between evaluations of symbolic attributes and adoption likelihood, and explore the potential role of attribution processes and the perceived signaling value of innovations in these processes.

Together, both studies show that people are not only interested in sustainable innovations for what they can do functionally, but also for what they can symbolize or signal to self and others [8,9]. Positive evaluations of the symbolic attributes of sustainable innovations may enhance the likelihood that people adopt sustainable innovations, particularly when adoption can be attributed to personal characteristics rather than to external circumstances. In this respect, our study extends previous research by suggesting that the relationship between evaluations of symbolic attributes and adoption of sustainable innovations is not only stronger when sustainable innovations have some instrumental drawbacks [3,4], but also when people believe that few significant others would consider adoption (e.g., when adoption norms are weak). Notably, we found this interaction effect for both interest in and intention to install a smart energy system, and for interest in an electric car, but not for the intention to adopt an electric car. Future research is needed to better understand the conditions under which weak adoption norms may strengthen (or weaken) the relationship between the evaluation of symbolic attributes and adoption likelihood.

The pattern of results was rather consistent for both indicators of adoption likelihood of both smart energy systems and electric cars, with some exceptions. Specifically, we did not find a unique relationship between evaluation of symbolic attributes and interest in an electric car, and no interaction effect of adoption norms and evaluation of symbolic attributes on intention to buy an electric car. Less statistical power of the test of the extended ISE-model in Study 2 compared to Study 1 due to the smaller sample size in Study 2 could possibly account for these differences. At the same time, the extended ISE-model better explained adoption likelihood of an electric car as compared to a smart energy system. Yet, importantly, we found that evaluations of symbolic attributes play a role for indicators of adoption likelihood for both sustainable innovations. Future studies could test the extended ISE-model further, and explore under which conditions and for which sustainable innovations evaluations of symbolic attributes are most likely to be related to adoption likelihood, and whether the strength of this relationship depends on the strength of adoption norms. Our results further suggest that both signals to self and others are likely to play a role, as the smart energy system is less noticeable to others than an electric car, and therefore most likely particularly serves as a signal to the self.

We conceptualized symbolic attributes as the extent to which adopting a sustainable innovation was believed to help build and support one's (desired) identity and status. In doing so, we did not specify what adoption tells about a person to self or others. Hence, we only considered whether symbolic attributes play a role in the adoption of sustainable innovations, and not what is being symbolized. Future studies are needed to examine what is being symbolized by the adoption of different sustainable innovations. The latter is particularly relevant for the design of campaigns to promote the adoption of sustainable innovations, as it reveals what characteristics could best be emphasized when communicating what using and owning a particular innovation means for people's identity and social position.

A limitation of the current research is that adoption norms were measured with a single item in both studies, which may be less reliable than a multi-item measure [30]. Future research could employ a multi-item measure, for instance by including items about perceptions of considerations, intentions and behavior of significant others in the adoption norm scale. Yet, importantly, we found similar results in both studies so we expect that the use of the single item scale is not a major concern for the current research.

In Study 1, part of the sample was recruited after respondents indicated they were interested in participating in the smart energy project. As a result, the sample recruited in Wave 2 reported a higher interest in and intentions to use smart energy systems compared to the sample recruited in Wave 1, which is not surprising. Yet, we believe it is not likely that differences in mean scores would affect differences in relationships among variables of interest. Indeed, we found a similar pattern of result in Study 2 where all respondents were recruited in the same time period, and where respondents did not participate in a project where the sustainable innovation would be tested.

We measured all constructs in one questionnaire, following a correlational design. Hence, we cannot draw firm conclusions about the causal direction of the relationships found. We reasoned that strong adoption norms increase the likelihood that people adopt a sustainable innovation, but it may also be likely that people who are considering to adopt a sustainable innovation in the near future may infer from this that others who are important to them are likely to do so as well. Future research could examine these relationships further by employing experimental designs, in which, for example, the strength of adoption norms is systematically varied, to examine how this affects evaluations of attributes of sustainable innovations as well as the adoption of such innovations (see [31] for an extensive review on improving research designs in energy social science). Furthermore, future research could include measures of actual behavior, for instance the actual purchase or use of a sustainable innovation, to test whether attribute evaluations and adoption norms affect actual adoption in a similar way as interest and intention to adopt a sustainable innovation.

4.2. Practical implications

Our research has some important practical implications. Stronger adoption norms seem to encourage the adoption of sustainable innovations. But does this imply that media campaigns should suggest high adoption rates during the early adoption phases? We argue it may not be wise to do so, on the basis of the second route via which adoption norms influence adoption likelihood that we identified in this research. Campaigns suggesting high adoption rates are likely to have only a small positive effect when the adoption rate is still clearly low, while they would undermine the impact of positive evaluations of the symbolic attributes on adoption. Are campaigns aimed to promote adoption therefore doomed to fail? Our research indicates that this is not necessarily the case. What adopting a sustainable innovation says about you seems to be more strongly related to adoption likelihood when adoption norms are weak. Highlighting or enhancing symbolic attributes is therefore likely to be a (more) effective strategy at the early stage, particularly when adoption norms are still weak. This strategy may particularly be promising as symbolic attributes are particularly important to people who are likely to adopt innovations at an early stage ([4,2,1]). Positive symbolic attributes of sustainable innovations could for example be stressed in campaigns emphasizing positive outcomes of owning and using sustainable innovations for one's identity and status. Such approaches could involve advertisements displaying owners of sustainable innovations who have a positive self-image and are positively evaluated by their significant others.

Yet, our results do also not imply that adoption of sustainable innovations should be promoted by downplaying adoption norms for the sake of strengthening the impact of the evaluations of the symbolic attributes. In fact, adoption norms are strongly positively related to the likelihood of adopting sustainable innovations. At later adoption stages, adoption norms will likely become stronger when sustainable innovations are more widely adopted. At this point, it makes sense to promote sustainable innovations by providing information on (strong) adoption norms, as this is likely to signal that adopting a sustainable innovation is "adaptive behavior". Adoption norms can be strengthened by highlighting the uptake of the sustainable innovation through marketing campaigns.

Our results could suggest campaigns should not emphasize positive instrumental and environmental attributes in promoting sustainable innovations, as evaluations of instrumental attributes and environmental attributes were not strongly related to the adoption of sustainable innovations. We believe that such a conclusion would be premature. Although evaluations of instrumental and environmental attributes of sustainable innovations did not always uniquely contribute to the explanation of the likelihood of adopting a sustainable innovation, we did find mostly significant positive correlations between the evaluations of these attributes and the likelihood of adopting sustainable innovations as well as adoption norms. Instrumental attributes and environmental attributes thus seem to matter to people, although evaluations of these attributes are not the most important and unique predictors of the likelihood that people will adopt a sustainable innovation.

4.3. Conclusion

To conclude, our results suggest that people are more likely to adopt a sustainable innovation when they believe that significant others would consider adoption, and when they evaluate the symbolic, and to a lesser extent, the instrumental and environmental attributes of the innovation more favorably, providing support for the extended ISE-model. Additionally, extending earlier research, we found that evaluations of symbolic attributes are more strongly related to the adoption of sustainable innovations when adoption norms are relatively weak.

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