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Research article

Consumer behaviour and climate action: insights from a Randomised Control Trial experiment in India's residential cooling sector

Vaibhav Chaturvedi [a,*], Apurupa Gorthi [a], Shikha Bhasin [a], Arnab Laha [b]

[a] Council on Energy, Environment and Water, India
[b] Indian Institute of Management Ahmedabad, India

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ABSTRACT

Air-conditioning is expected to be the largest consumer of residential energy in India in the future. Good consumer practices related to servicing air-conditioners (ACs) are critical for maintaining high operational efficiency of ACs and reducing leakages of high global warming potential (GWP) refrigerant gases. Little information, however, is available about the knowledge and practices of Indian AC consumers in terms of their operational practices. The Government of India's 'India Cooling Action Plan (ICAP)' recommends a massive consumer awareness program to inform and change AC user behaviour. Within this context of the ICAP that aims to provide access to sustainable cooling to its masses while minimising its environmental impacts, we undertake a survey and a Randomised Control Trial (RCT) experiment including Indian consumers. The survey and experiment together aim to understand the AC servicing behaviour of Indian consumers and experiment with alternative interventions to influence their behaviour and glean insights for India's energy and climate policies. The behavioural experiment is a unique and novel methodological contribution to India's cooling and climate debate. This research is a first-of-its-kind RCT study of Indian consumers' AC servicing practices. We find that the AC users' knowledge of the importance of preventive servicing is much lower than required. The interventions were successful in enhancing general awareness related to the importance of servicing practices, but not in enhancing technical knowledge related to specific good servicing practices. Our analysis shows that consumers who know about the economic benefit of servicing are more likely to undertake preventive servicing. Our findings highlight the presence of information asymmetry in the Indian residential cooling market and argue that this needs to be addressed for achieving the desired behavioural change and actions to mitigate climate change.

1. Introduction

The Government of India (GoI) recently released the India Cooling Action Plan (ICAP; GoI, 2019). This strategic policy document aims to achieve thermal comfort for all Indians and provide cooling solutions across sectors, while simultaneously enhancing energy efficiency, mitigating climate change, generating livelihood opportunities, and changing consumer behaviour. For achieving the last of these targets, the ICAP recommends massive customer awareness program focusing on the impact of proper maintenance on energy efficiency and refrigerant leakage. Changing consumer behaviour is an integral part of the ICAP.

Behaviour change, as also highlighted in the ICAP, is critical for the world to achieve the goals of climate change mitigation. Inculcating pro-environmental behaviours in the form of energy efficiency or energy conservation practices among households has been studied by many behavioural scientists and economists (Abrahamse et al., 2005; Frederiks et al., 2016; Steg 2008; Ščasný and Urban 2009; Moore and Boldero 2017; Banerjee et al., 2015; Gandhe and Pandey 2017). A key argument for investing in behavioural interventions has been their low cost of implementation relative to investing in high-end technology to bring a similar effect (Allcott and Mullainathan, 2010). Especially for greenhouse gas (GHG) abatement, Allcott and Mullainathan (2010) argue that behavioural interventions can be a lot less cost intensive to implement than alternatives such as investing in R&D for carbon-neutral technology or replacement of fossil-fuels in electricity generation.

Policies for inducing behaviour change, however, face many challenges. For instance, in a qualitative assessment on factors influencing household's adoption of energy efficient behaviours, "lack of reward and motivation" was indicated as a major impediment (Sony and Mekoth, 2018). The respondents indicated that they were not motivated to

* Corresponding author.
E-mail address: vaibhav.chaturvedi@ceew.in (V. Chaturvedi).

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indulge in energy conservation activities as it did not result in substantial savings in electricity bills. Another challenge is lack of information, and information related to energy conservation was perceived to be too technical (Sony and Mekoth, 2018). Irrespective of the challenges, communication from the government was an important influencing factor (Sony and Mekoth, 2018). Motivational factors, and the context, hence become critical for inducing pro-environmental behaviour (Steg and Vlek, 2009; Moore and Boldero, 2017)

Motivating consumers to adopt climate friendly practices for residential air-conditioners is an important intervention for achieving climate goals. Space cooling is expected to emerge as the largest source of energy consumption in Indian households in the long run (Chaturvedi et al., 2014). Space cooling, in particular, has also been identified as a policy priority by the Government of India (GoI, 2019) in the ICAP as well as in other policy domains, not just for the potential energy efficiency gains, but also due to potential GHG emissions reductions resulting from leakage of high global warming potential (GWP) refrigerants during AC use. In the absence of the Kigali Agreement of the Montreal Protocol, direct HFC emissions from the residential cooling space would have contributed to 36% of the total global warming impact of this sector in 2050 irrespective of the economic growth scenario. In addition, adopting sustainable lifestyle practices, including higher AC energy efficiency and lower refrigerant leakages among other things, has the potential to reduce the global warming impact of this sector in India by 46% during 2010–50 (Chaturvedi and Sharma, 2016).

Adopting good servicing practices[1] (GSPs) is critical to optimise the energy efficiency potential of AC equipment as well as minimise leakages of high GWP refrigerants (Sridhar and Chaturvedi, 2017). The ICAP recommends devising and implementing an awareness generation strategy for influencing the servicing practices adopted by Indian consumers. Little information, however, is available about the knowledge of Indian consumers on good servicing practices and if an awareness strategy could impact their behaviour. Within this context of the ICAP, we undertake a Randomised Control Trial (RCT) experiment to understand the AC servicing behaviour of Indian consumers and experiment with alternative interventions to influence their behaviour and glean insights for climate policy.

Randomised Controlled Trials (RCT) is a quantitative experimental technique used to gather such evidence. In a methodological review on RCTs, White et al. (2014), defined this methodology as *'a way of doing impact evaluation in which the population receiving the programme or policy intervention is chosen at random from the eligible population, and a control group is also chosen at random from the same eligible population. It (RCT) tests the extent to which specific, planned impacts are being achieved.'* The behavioural experiment is a unique and novel methodological contribution to India's cooling and climate debate. This research is a first-of-its-kind RCT study of Indian consumers' AC servicing practices.

With the help of a survey of consumer behaviour and an RCT experiment, we seek to answer the following questions: (i) what is the understanding and behaviour of Indian AC users in terms of knowledge of environmental and economic implications of AC servicing, average cost and willingness to pay for servicing, time spent in servicing, and choice of servicing technicians; (ii) of the two key messages- environmental benefit versus economic benefit – which one is more effective in influencing consumer awareness levels and servicing practices; and (iii) what should be the key elements of GoI's awareness generation strategy to facilitate climate friendly action on the ground? In the following sections, we present in detail the survey and experimental methodology, results of the survey and RCT experiment, key insights, discussions and conclusion.

2. Methodology: the experimental framework

2.1. Randomised Control Trial

The study was conceptualised as a randomised controlled trial (RCT) experiment to discern the impact of the intervention (information on AC servicing practices) on households' awareness and practices. RCTs have been found to be useful to measure the causal effect of interventions, that is, the existence of a cause-and-effect relationship between an intervention and its intended outcome can be determined (Frederiks et al., 2016). This is especially useful to study the effectiveness of a policy or measure change in human behaviour in response to interventions. The meticulous sampling procedure followed in RCTs ensures that external factors are fully controlled for; thus, any effect can be attributed solely to the intervention. Sufficient sample size and randomisation also ensure that the treatment and control groups have similar representation. Such a representation helps assess change affected by an intervention between the various treatments.

We follow the 'Test, Learn and Adapt' framework, as proposed by Haynes et al. (2012) for our RCT experiment. This framework outlines nine key steps to conduct an RCT. We explain each step in detail, as proposed originally as well as how it was incorporated in our study, below:

(i) Identification of policy interventions to be compared, that is, old vs. new policy or variations of one policy: The policy intervention that we consider in our experiment is awareness about the importance of good servicing practices and regular servicing. We separate our intervention for two treatment groups. One that receives information on environmental benefits of following GSPs, and the other that receives information on economic benefits of following GSPs. This, essentially, intends to test the potential impact of awareness campaign based on environmental messaging versus a campaign with messaging focused on an individual's own economic benefit. This is tested against the control group that receives no message related to GSPs.

(ii) Determination of the intended outcome of the intervention and how it will be measured: We measured two outcomes. The first related to awareness of the importance of GSPs; and second, related to the change in behaviour as a result of increased awareness, i.e. increase in the actual number of AC servicing.

(iii) Decision on the randomisation unit (individual or clustered): The unit of data collection and analysis was households. Given that urban areas dominate residential AC use in India, sample households were randomly chosen from cities, as explained later in this section. In each household, we collected response only from the member who took decisions related to the purchase and maintenance of ACs. If there were more than one ACs in the household, we collected basic information on all ACs, but the focus of the survey questions was on the AC that was at least two years old and was the most frequently used AC in the household.

(iv) Sample size determination in terms of the number of units (people, institutions or areas) required to ensure robust results: This RCT considered the need for both randomisation and geographic diversity in its sampling procedure. A list of cities with a population of 10 Lakh and above was compiled based on Census 2011 data (GoI, 2011; see Annexure 1)[2]. The size of the city is also a measure of the economic activity of the city. For example, the biggest cities in India are the metros that are also the most populous and have a significant number of high income people who own ACs. The reason for choosing from cities over 10 Lakh population is to ensure that there are enough households in a

[1] Refer https://www.ceew.in/sites/all/themes/ceew/images/CEEW-10-step-guide-to-maintain-room-ACs-16Aug19.pdf for a list of good servicing practices for maintaining room ACs.

[2] Refer Supplementary Material file 'Heliyon - RCT_SupplementaryMaterial_Dec 2020' for all annexures.

given area who own an AC and are willing to be a part of our experiment. In smaller cities with lower penetration of ACs, sampling for our study would be very resource intensive. These were further classified based on the geographic zones of North, South, East and West. One city was randomly picked from each zone: Meerut, Madurai, Dhanbad, and Vadodara were selected respectively. Randomisation was employed at every level of sampling, starting from city selection to the specific households surveyed. Enumerators contacted the local municipalities for a list of wards and housing localities within these wards for this from which the ward and locality selection was done randomly. After randomly selecting the four cities in each zone, randomisation within cities was done at the level of wards (6 wards randomly chosen in each city) and housing localities (3 housing localities randomly chosen in each ward). Six households were chosen within each of the randomly chosen housing localities. The households were chosen using the 'right hand rule', with every fifth household on the right being chosen. Only those households possessing at least one AC unit for two years or more were considered for the survey. If the chosen household didn't meet the selection criteria, was not available or interested in participating in the survey, the next household was chosen as the participant subject to its agreement and fulfilment of the selection criteria. 432 households were recruited (108 in each city) to participate in the survey.

(v) Use of randomisation method for the assignment of policy intervention to the units and creation of treatment(s) and control groups: 108 households in each of the four cities were randomly assigned in one control group and two treatment groups (TG1 and TG2), as our study intended to test the impact of two alternative messages: environmental versus economic.

(vi) Administration of the intervention to the treatment and control groups: The intervention was administered at the household level between June and November 2019. During the baseline survey (undertaken in the first two weeks of May 2019), participating households were informed about receiving messages, and the mobile phone number from which these messages would be sent were shared. Consent for participating in the survey as well as for receiving interventions was taken from each of the respondents at the start of each interview. The intervention messages were sent to the households via SMS in the most popular regional language, in both the original and in English text. This was Hindi for Dhanbad and Meerut, Gujarati for Vadodara and Tamil for Madurai. In terms of the specific information conveyed in the intervention, households assigned to the control group received a thank you message for their participation every month and a half. Fortnightly messages containing information on the importance of servicing and GSPs was sent to the two treatment groups. While the information on servicing remained the same between the treatment groups, the main distinction was in the specific theme for motivating households. To this end, messages for TG1 focused on the positive impact of a specific servicing practice on the environment, and messages for TG2 focused on potential economic benefit in the form of reduced electricity bill resulting from the same GSP. Annexure 2 presents the specific dates and messages sent during the six-month period the intervention was administered. Pamphlets containing information on the importance of regular servicing and their impact on the environment and economic savings were mailed to the respective treatment groups at the midpoint of the intervention period, in the first week of September 2019. From the month of September, a dedicated website link[3] containing information on specific servicing practices and how they must be administered during servicing was also shared with households. These were simply a list of good servicing practices and did not contain information on benefits focusing on the environment or economic savings through electricity bills. Phone calls were made in the middle of the intervention period to ascertain that messages were being received and read by the respondents.

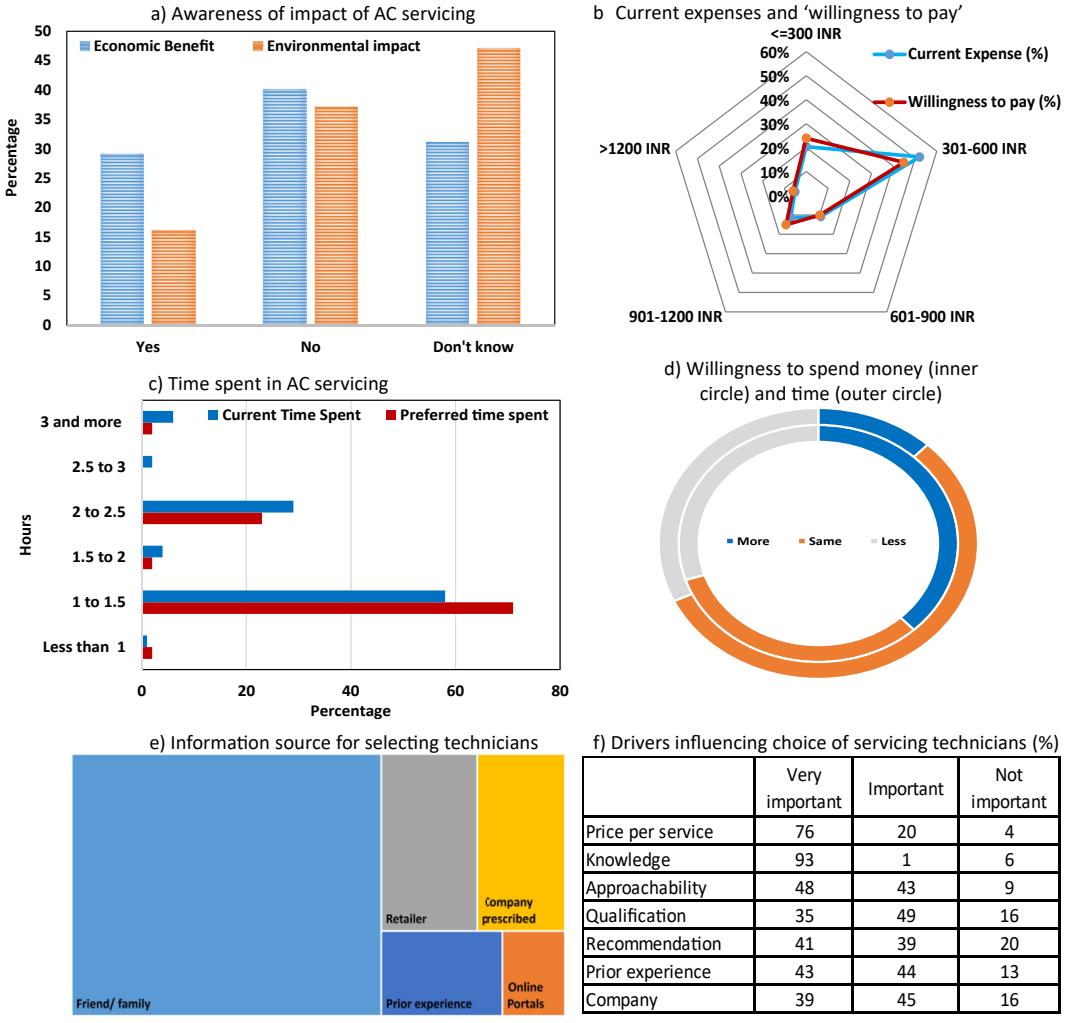
(vii) Result measurement and determination of the impact of the intervention: The result in terms of the impact of the interventions on the two treatment groups, in reference to the control group, was measured through an end-line survey administered in the first two weeks of December 2019, after the end of AC usage season. Information on basic demographic parameters, awareness levels related to GSPs, and servicing practices was collected along with other relevant information. The end-line survey focused on a lesser number of variables that were required to measure impact as well as check for the robustness of data. Impact of the interventions was determined with the help of regression equations formulated for the same, incorporating information from both the baseline survey and the end-line survey. The detailed regression equations and results are presented in the results section.

The two final steps as per the prescribed RCT framework are (viii) Policy interventions adapted reflecting the results of the RCT experiment; and (ix) Return to Step 1 and repeat the process to fine-tune understanding on the policy intervention that could work the most successfully. These essentially imply informing policies based on the RCT experiment results. Ames and Wilson (2016) also highlight that RCTs should complement any existing policy-making processes rather than replacing them. As highlighted in the introduction section, this study was undertaken to inform the recommendations of the ICAP, with respect to the awareness generation campaign recommended by the ICAP for ensuring that consumers follow GSPs. The learning from our experiment will be used to inform the ICAP recommendations. We intend to follow the last two steps in the near future, once our results have been reviewed and published.

The baseline survey was conducted in May 2019. Based on the baseline survey, questions attempting to measure the impact of the RCT on consumer awareness and practices related to GSPs were repeated in the end-line. The end-line survey was conducted in December 2019, after six months of intervention. Many RCTs are undertaken in tightly controlled settings, where participant drop-out rates might be very low. Our study was undertaken across cities to ensure representativeness and generalisability of the statistical results of the experiment, given that it seeks to inform a national action plan. Finally, of the 432 households participating in the baseline, 338 were interviewed in the end-line, indicating an attrition rate of 22% overall. For analysing the impact of our experiment, we further excluded those households that indicated that they had not read the intervention messages. Of the 338 households in the end line survey, only 199 respondents mentioned that they have received and read our intervention. We undertook other checks specific to input data for our regression equations, explained as applicable in the results section, to ensure the robustness of our results. The baseline results have been presented for all the respondents. The experiment's results have been presented after excluding the drop-outs, people who have not read the intervention messages, and people whose responses didn't clear the robustness check for specific questions. The baseline and end-line questionnaires are presented in Annexures 3 and 4, respectively. Annexure 5 presents the comparison for the baseline and the subset data used for our models (after excluding dropouts and non-robust responses) on demographic and AC characteristics. The comparison shows that the baseline sample data and both the subsets are similar in terms of the various characteristics.

We present the general results of our baseline survey for all 432 respondents, and the results for the regression models based on reduced sample size (specified in relevant parts of the results section) after checking for robustness.

[3] https://www.ceew.in/sites/all/themes/ceew/images/CEEW-10-step-guide-to-maintain-room-ACs-16Aug19.pdf.



f) Drivers influencing choice of servicing technicians (%)

	Very important	Important	Not important
Price per service	76	20	4
Knowledge	93	1	6
Approachability	48	43	9
Qualification	35	49	16
Recommendation	41	39	20
Prior experience	43	44	13
Company	39	45	16

Figure 1. Consumer knowledge and practice related to AC servicing (N = 432).

3. Results

3.1. Consumer knowledge and practices related to AC servicing

For describing results related to consumer knowledge and practices, we share insights from the full set of respondents (432) for whom data were collected as a part of the baseline survey.

3.1.1. Consumer knowledge of the environmental and economic benefit of servicing

The larger motivation of our study is to influence consumer behaviour through communication programs that motivate consumers to undertake better servicing practices. Environmental and economic benefits are the two key motivations identified and used in our intervention strategy.

The former could be construed as comparatively altruistic in nature, whereas the latter could be construed as comparatively self-centred. Our question on the potential impact of AC servicing on energy efficiency implicitly implies economic benefit as energy savings directly translates to economic benefit. This is supported by the result that of the respondents who report a positive impact of AC servicing on energy efficiency, 81% report a substantial or large contribution of ACs in their monthly electricity bill.

We first attempt to understand, based on the baseline survey, if consumers are aware of these two benefits. We find that most of the consumers either have no idea of any connection or think that good AC servicing practices do no effect either environmental or economic aspects (Figure 1a). That said, comparatively more people (29%) think that GSPs lead to economic benefit through energy savings as compared to the number of people who think that GSPs positively impact the environment (16%).

3.1.2. Current expenses and 'willingness to pay' for servicing

AC servicing is a technical job, and what consumers pay and are willing to pay becomes very important for the delivery of good service. In terms of current average expense on servicing, a large chunk of consumers (52%) pays between INR 300–600 per servicing (Figure 1b). The willingness to pay, on average, is not too different either, with a bulk of consumers (45%) willing to pay in the same 300–600 INR per servicing range, while 24% want to spend even lower than INR 300 per servicing. Almost a third of all respondents indicated a willingness to pay higher charges for servicing[4]. At the same time, interestingly, nearly an equal number of respondents, expressed an interest to pay a lower amount than what they are currently paying (Figure 1d). There is a clear and obvious trend in the

[4] It would have been interesting to understand better the underlying reasons for the various results that we find, e.g. 'willingness to pay', awareness related to economic versus environmental benefit. This, however, would entail collecting information for more underlying variables which could impact the behaviour related to interesting findings like 'willingness to pay'. This analysis was outside the scope of our study and would be an area of future research.

number of people who want to spend less compared to what they pay currently. Of people who currently pay over INR 900 per servicing, more than 50% want to reduce this expense by at least INR 100; while of people who currently pay <300 INR per servicing, 10% want to reduce this expense by at least INR 100.

3.1.3. Time spent in AC servicing

Time is a valuable commodity. It is generally understood that servicing an AC is a time-consuming process. In our survey, most of the consumers (58%) mentioned spending 1–1.5 h of their time for monitoring AC servicing in their households (Figure 1c). A significant share (29%) also mentioned spending 2–2.5 h for the same. As compared to the average time spent currently, 71% respondents mentioned the preferred time duration to be spent on this necessary activity as between 1-1.5 h. Almost a third of respondents indicated a desire to spend less time on AC servicing. It is clear, by the set of responses, that a large proportion of consumers do not want to spend beyond 1–1.5 h on servicing. This result is very important because adhering to all key GSPs during one servicing could take at least 2 h. Consumers need to be willing to allocate at least this amount of time, which is not evident from the responses in our survey.

3.1.4. Choice of servicing technicians

The process of choosing a servicing technician is a critical one as it impacts consumer experience as well as the performance of the AC and consumer satisfaction and comfort. A large number of consumers depend on their network of family and friends as an information source for hiring technicians (Figure 1e). Trust, as a factor, is very important in this process, and this result shows that consumers put much more trust in their private network as compared to any other network, be it retailers, companies, or online sources. Retailers come a distant second after personal networks. Traditionally, in India, internet penetration has been low and online services have only started making a mark in the last two years, that too in the large cities of the country. The randomly chosen cities in our survey are smaller cities, that are truly representative of a large part of the Indian urban customer base. Online application-based services have not yet made a significant mark in these cities as of now, which is also reflected clearly in our survey. This, however, could change in the future will continued boom of internet across the country.

In terms of the drivers influencing the choice of servicing technician, knowledge of technicians by far is the most important driver as highlighted by the respondents (Figure 1f). A majority of respondents (73%) indicated that service technicians informed them of serving practices undertaken during servicing. However, in terms of awareness on the various servicing practices listed in the questionnaire, while 70 per cent of the respondents indicated familiarity with 'filter cleaning' and 'measure current and voltage', all other servicing practices were typically recognised by less than 50 per cent of the respondents. Along with providing information, a majority of respondents (63%) indicated that the servicing technician also advised them on good maintenance practices. However, a common response for good maintenance practice(s) that was suggested was regular cleaning of the AC. A few respondents also mentioned frequent filter cleaning and annual maintenance by a service technician as good maintenance practices they followed. Thus, while consumers perceive the knowledge of the technician as the most crucial variable, it is clear that as the knowledge related to GSPs is technical, they are not well placed to evaluate the quality and depth of information being provided by the servicing technician.

Along with technician knowledge, price is also a very significant variable ranked as being 'very important' by three-fourth of respondents. Other factors are far less critical, and these two variables – technician knowledge and price of servicing- could be collectively taken as determining the choice of servicing technician (Figure 1f).

3.2. Impact of intervention on consumer awareness level

In this section, we present the results of our intervention on the level of consumer awareness. We tested consumer awareness with the help of two questions. The first question was related to their own awareness level, and the second related to knowledge of how many GSPs have they observed before and after the intervention. Our approach is based on Ciochetto and Haley (1995), who describe the difference between awareness questions and knowledge questions, with the former being generic, while the latter being comparatively more specific. Through the first question, we aim to understand if our intervention was able to impact the general consumer awareness level. During the baseline and end-line, respondents were asked to rank their self-awareness using a 3-point Likert scale of 'Well aware (3)', 'Somewhat aware (2)' and 'Not aware (1)'. As the dependent variable was an ordinal variable, an ordinal logit regression model was opted for this analysis.

For ensuring correctness of analysis for this question, the households that reported a decline in their first-order subjective awareness levels[5] (Timmermans and Cleeremans, 2015) between the six months were excluded as this implied inconsistency between the response in the baseline and end line survey. The inclusion of these inconsistent responses would lead to spurious results. Only those households that showed a relative increase, or were at the same awareness level, were considered for this analysis, resulting in 115 respondents being considered. The following regression equation was used for this analysis.

$$Ln(Y_i) = \alpha_0 + \alpha_1 Age_R + \alpha_2 Edu_R + \alpha_3 Gen_R + \alpha_4 Treatment + \alpha_5 Pre\_awareness \quad (1)$$

Where,

Y_i represents the level of awareness of the respondent after the intervention

Age_R represents the age of the respondent

Edu_R represents the respondent's education qualification classified into three levels, 1 = Not completed high school; 2 = Completed high school but not UG; 3 = Graduation and above

Gen_R represents respondents' gender

Treatment takes three values depending on whether the household is in the control group, in TG 1 (environmental benefit) or in TG2 (economic benefit)

Pre_awareness Level of awareness of the respondent at baseline

On deeper examination of the above-proposed model, it was found that all the explanatory variables are not independent, leading to problems in parameter estimation. The test of multicollinearity is presented in Annexure 6. We remove some of the explanatory variables one-by-one until the problems associated with multicollinearity and separation are resolved. We, therefore, used a reduced form model after removing variables as required for robust statistical estimation, as denoted in Eq. (2).

$$Ln(Y_i) = \alpha_0 + \alpha_4 Treatment + \alpha_5 Pre\_awareness \quad (2)$$

The variable 'Treatment' contains information on whether the household is in the control group, in the treatment group to which the environmental benefit message was administered, or the treatment group to which the economic benefit related to the energy saving was considered. Pre-awareness was categorised in three levels. The reference level for the regression was 'not aware', and the other two levels were 'somewhat aware' and 'well aware'.

The results are given in Table 1:

From the results reported in Table 1, we conclude that both the interventions, the practice of GSP for environmental or economic benefit,

[5] see Timmermans and Cleeremans (2015) for a discussion on subjective and objective measurement approaches of awareness levels. We use a first order subjective approach for measuring the general awareness of our respondents.

Table 1. Impact of intervention on the level of awareness (results from ordinal regression).

	Value	Std. Error	t value	p value
Somewhat_Aware	1.238438	0.5594414	2.2137045	0.027
Well_Aware	13.019013	43.0167157	0.3026501	0.762
EnvBenefitMsg	1.615960	0.6408693	2.5215122	0.012
EconBenefitMsg	1.104865	0.6099950	1.8112688	0.070
Intercept: 1|2	-1.698594	0.5436924	-3.1241822	0.002
Intercept: 2|3	2.546303	0.5928228	4.2952172	0.000

Note: Reference value for awareness is 'Not Aware'.

have a significant (at 10% level of significance) and positive impact on increasing the awareness level of the consumer. We also note that the impact of the interventions is significantly higher for consumers who reported that they were "Somewhat aware" during the baseline survey compared to the group that reported that they were "Not aware". It may be conjectured that (i) consumers in this group were looking for more information about GSPs and the interventions served to meet their information requirements; or/and (ii) some basic level of awareness in recipients is instrumental in magnifying the impact of an awareness generation campaign in the target population.

In order to test for respondents' knowledge of good servicing practices, we checked for the reported number of GSPs observed during servicing. This was asked for seven common activities performed by servicing technicians during general AC service. Only responses from the end-line survey were considered for this. Here, we did not distinguish between the environment and energy savings treatments as information on the specific practice to be performed was the same. All respondents who had received and read the intervention messages, i.e. 199 respondents, were considered for this analysis.

servicing practices through an awareness generation campaign run by the Government of India.

For checking the robustness of responses related to this question, we included one specific question in our baseline as well as end-line survey. In the baseline survey conducted in May 2019, where we collected information for May–November 2018, we specifically asked respondents to specify months in which servicing was undertaken. In the end-line survey, we asked respondents to indicate the total number of services undertaken in the 2018 season, i.e. May–November 2018. Wherever the response between the baseline and end-line varied, we excluded that respondent from our analysis. Based on this check, a total of 113 households were considered for this analysis. Of these households, in terms of the average number of maintenance related servicing undertaken, an overwhelming 75% of AC users responded undertaking no preventive servicing in 2018, and 24% reported undertaking one preventive servicing in 2018.

Responses were arranged such that the frequency of servicing both in the baseline and end-line were tested in the model against various independent variables represented in Eq. (1).

$$Yi \sim Poi(\lambda i) \quad \text{where } \boldsymbol{exp}(\boldsymbol{\lambda i}) = \beta_0 + \beta_1 Post1\_Pre0 + \beta_2 Age_R + \beta_3 Edu_R + \beta_4 Gen_R + + \beta_5 EnvBenefitAware + \beta_6\ EconBenefitAware + \beta_7\ EnvBenefitMsg + \beta_8\ EconBenefitMsg + \beta_{75}\ EnvBenefitMsg * EnvBenefitAware + \beta_{86}\ EconBenefitMsg * EconBenefitAware + \beta_{76}\ EnvBenefitMsg * EconBenefitAware + \beta_{85}\ EconBenefitMsg*EnvBenefitAware \tag{3}$$

The results of the test of proportions (Table 2) show that the treatment is not effective in significantly increasing the proportion of people who observe any of the GSPs, as compared to that in the control group.

The two results, when looked together, present an interesting insight. The awareness intervention is successful in creating some general awareness in customers about the importance of GSPs. However, it still doesn't lead to a higher share of consumers observing specific GSPs. We argue that this is because of the technical nature of information associated with specific GSPs. The more technical the information, the more difficult is it for consumers to process and remember it. Thus, an awareness generation campaign with a high-level message could be successful in its objective; while one with more technical messaging would find it challenging to achieve its objective.

3.3. Impact of intervention on servicing practices

Arguably, the most important question for us is the impact of awareness generation intervention on actual servicing practices. Information on the frequency of preventive servicing in 2018 and 2019 were collected from the respondents. Essentially, we aimed to learn if the number of AC servicing done by households between April and November for the years 2018 and 2019 had changed as a result of the intervention. This is the most important question for us as ultimately, we intend to change the actual behaviour of people in terms of their AC

Here,

β_0 represents constant in the regression equation

*Post*1_*Pre*0 is a dummy variable representing if the information is for year 2018 (pre intervention) or 2019 (post intervention)

Age_R represents age of the respondent

Edu_R Respondent's education qualification classified into three levels, 1 = Not completed high school; 2 = Completed high school but not UG; 3 = Graduation and above

Gen_R represents respondents' gender

EnvBenefitMsg Households that received the treatment focused on environmental benefit

EconBenefitMsg Households that received the treatment focused on economic benefit through energy savings

EnvBenefitAware Households that indicated awareness towards the impact good servicing practices had on the environment in the baseline survey

EconBenefitAware Households that indicated awareness towards the impact of good servicing practices had on the economic benefit through energy savings in the baseline survey

*EnvBenefitMsg***EnvBenefitAware* Households that received the treatment focused on environmental benefit and displayed awareness towards the impact of good servicing practices on the environment in the baseline survey

Table 2. Results from test of proportions.

	Control			Both treatments combined			P-value	Confidence Interval (90%)	
	Yes	Total	Prop	Yes	Total	Prop			
Current and voltage check	67	115	0.58	48	84	0.57	0.99	-0.13	0.16
Filter cleaning	99	115	0.86	76	84	0.90	0.47	-0.14	0.06
Leak testing	47	115	0.41	41	84	0.49	0.33	-0.23	0.07
Cleaning AC	92	115	0.80	66	84	0.79	0.95	-0.11	0.14
Earthing check	50	115	0.43	32	84	0.38	0.54	-0.09	0.2
Venting refrigerant	20	115	0.17	10	84	0.12	0.39	-0.05	0.16
Recovery of refrigerant	19	115	0.17	10	84	0.12	0.48	-0.06	0.15

*EconBenefitMsg*EconBenefitAware* Households that received the treatment focused on energy savings and displayed awareness towards the impact of good servicing practices on the energy savings in the baseline survey

*EnvBenefitMsg*EconBenefitAware* Households that received the treatment focused on environmental benefit and displayed awareness towards the impact of good servicing practices on the energy savings in the baseline survey

*EconBenefitMsg*EnvBenefitAware* Households that received the treatment focused on energy savings and displayed awareness towards the impact of good servicing practices on the environment in the baseline survey.

A Poisson regression model was fitted to the observed data. The test of multicollinearity is presented in Annexure 7, and this is not an issue. We find that several variables in the above model were not significant at a 10% level of significance. In keeping with the principle of parsimony, we removed the non-significant variables one-by-one until we arrived at a model with only significant variables. We use this model for further analysis and interpretation.

$$Y_i = \beta_0 + \beta_1 + Post1\_Pre0 + \beta_6\, EconBenefitAware \quad (4)$$

The results (Table 3) reveal three interesting insights: (i) respondents who displayed an awareness of the economic benefit of servicing in the baseline survey were more likely to undertake preventive servicing as compared to those who were not aware of it, with the expected number of servicing undertaken by consumer aware of the economic benefit higher than consumers with no such awareness (ii) our interventions, both on environmental and economic benefits of servicing, were unable to change the behaviour of consumers included in our experiment, and (iii) the number of people undertaking preventive servicing of their ACs is larger in 2019 compared to 2018. While we could not attribute (iii) to any of our two interventions, we note that this may be an early indication of the start of a healthy trend. However, our optimism needs to be guarded as most AC users (62%), even in our end-line survey, did not undertake any preventive servicing in 2019; though this number was lower than that in our baseline survey where 75% AC users did not undertake preventive servicing. The first and second insights highlighted above are conflicting, and we explain this in section 4.1 below.

4. Discussions and key insights

4.1. Focusing on economic benefits could be key

Our estimates present conflicting results. On the one hand, our estimates find that people who know about the economic benefits are more likely to undertake preventive servicing based on information in the baseline. At the same time, however, though the interventions are effective in building awareness, these are not successful in changing behaviour within our experimental setup. These conflicting results are possible as our interventions, that try to mimic a government awareness campaign, are not a thorough replacement of a massive government campaign. The government campaigns, in reality, include a high decibel array of messages through visual mediums such as billboards, newspaper, television and internet advertisements, spread across a period of multiple years to bring about behavioural change. Though our interventions sent through frequent messages and pamphlets are successful in mimicking the real-world awareness campaigns to some degree as supported by our results in terms of improvement in awareness levels, these are still only a partial representation of a real-world government awareness generation campaigns that operate at a different scale. The results from the baseline clearly indicate that messaging related to the economic benefit of regular and proper AC servicing when propagated through a mass government campaign that consistently sends this message would increase the likelihood of people adhering to good servicing practices. This should be an essential element in the GoI's awareness generation strategy.

4.2. The lemons problem

Our survey has revealed an interesting insight related to the issue of information asymmetry, and how it could influence decision making that has an impact on the climate. Our study found that while consumers perceive the knowledge of the technician as the most crucial variable, they are not well placed to evaluate the quality and depth of information being provided by the servicing technician (see section 3.1.4). This is because of the technical nature of information related to GSPs, with very few consumers knowing anything more than filter cleaning and voltage/current testing, even after our dedicated intervention. Even the channel for selecting a technician is a channel based on trust, rather than any evaluation of skills that technicians have. The channel of trust is mainly based on experience with a technician, and if the service has led to satisfying customer experience, that is influenced by many variables. In our baseline survey, 91% reported an improvement in AC performance after servicing, and 100% reported satisfaction with the technician, which implies repeat of the same technician irrespective of the level of formal training and expertise of the technician. This AC user behaviour is irrespective of the fact that most of the technicians are untrained and come from what is characterised as the informal sector, a common aspect of any developing economy (Sridhar and Chaturvedi, 2017).

The lack of capability to assess the quality of servicing technician creates what is known as the problem of lemons in the market. The

Table 3. Impact of intervention on number of servicing (results from Poisson regression).

	Estimate	Std. Error	z value	Pr (>|z|)
Post1_Pre0	0.4394	0.2381	1.845	0.0650
EconBenefitAware	0.4973	0.2435	2.042	0.0411

lemons problem, first highlighted by Nobel laureate George Akerlof in his seminal work on information asymmetry (Akerlof, 1970), arises due to the asymmetric information between the buyer and seller of a service/-good about the value of the service/good. In our AC servicing sector context, it is impossible for the customer to differentiate between high quality and knowledgeable service technician, and the one who is below par. Their choice, as we show, is influenced mainly by personal trust networks. All freelance technicians claim to be good. However, only after the customer has selected the technician can he or she find out the quality of the technician. In fact, for basic servicing, most times the customer will not be able to decipher the difference.

This situation leads to what is known as 'adverse selection' in the market. The lemons, or sub-par/partially-trained technicians, reduce the average price of the market as they offer services at the lower price, and the buyer is ready to pay the price that reflects only the average quality of the market. This is evident from the result that over three-fifth of the respondents either have the same or lower willingness to pay, compared to what they currently pay. In this situation, the sellers of good quality service (i.e. high-quality servicing technicians) will not want to sell their service at the average price but are compelled to do so in the face of competition from the lemons. This forces them to reduce the quality of their service to the average level. There is no incentive to perform better. Policy makers and planners need to devise ways to eliminate the information asymmetry in the market, for improving the quality of the service, as well as eliminate lemons from the market.

4.3. Informing the GoI communication strategy

One of the key recommendations of the ICAP is an awareness generation plan for influencing the operational behaviour of AC users. Our study provides information on various aspects of AC users, as well as tests the impact of alternative interventions to inform the plan. The following findings are directly relevant to the GoI awareness generation program: (i) most AC users are unaware of the potential benefits of adopting good servicing practices and don't go for preventive servicing voluntarily; (ii) AC users aware of the energy savings and associated economic benefits of servicing are more likely to undertaken preventive servicing; (iii) most AC users do not want to spend more than 1.5 h for servicing; (iv) most AC users do not want to pay more than INR 600 per servicing; and (v) both environmental and energy savings related messaging are successful in enhancing high level awareness of the importance of servicing, though these are not effective in enhancing technical awareness on good servicing practices. Based on these findings, the key messages in the GoI awareness generation program should: list the benefits of adopting preventive GSPs with a focus on the economic benefit while including both environmental and energy savings aspects in the communication strategy; emphasize that regular proactive servicing is a must; highlight that good basic preventive servicing needs at least two hours, the time expected for proper servicing; motivate customers to be ready to pay higher for good servicing, and; emphasize the importance of a good servicing technician. A certification system, as explained in the section 4.5, has to be a key complementary measure and if a universal certification system is adopted in the future, that should also become an element in the communication strategy.

4.4. The complementary role of manufacturing companies in awareness generation

Manufacturing companies play an important role in the AC market structure. These, through their various sales channels, have been instrumental in spreading the word about the appliance star rating programme of the Government of India. Interestingly, however, there doesn't appear to be any concerted set of actions by the companies to make AC users aware of the importance of preventive servicing, and the information is largely shared by the servicing technicians to AC users. Manufacturing companies can play an important complementary role in awareness generation about the positive benefits of preventive servicing. For example, they can develop a short awareness generation brochure in vernacular languages focusing on good servicing practices and their benefits and share it as a part of the AC kit along with other documents like warranty card and user manual. Ideally, such a brochure should have standardised information across AC companies to ensure that a consistent set of information flows. Such actions by the manufacturers could go a long way in helping the GoI efforts in generating consumer awareness.

4.5. From awareness to action: the need for standardized certification along with consumer awareness

Awareness is a prerequisite for behavioural change. It is a necessary condition for action. Our results find something very interesting in this regard. AC servicing requires technical knowledge. Also, almost 85% of respondents in the baseline survey find technical knowledge of servicing technicians important or very important (Figure 1f). We find that though our intervention successfully resulted in an increased level of consumer awareness, it did not lead to any change in action, given that our interventions can only partially represent the scale of a government or industry led awareness campaigns. Moreover, it led to only a general awareness about the impact of servicing on the environment or energy savings, not a detailed understanding in terms of the exact steps that need to be practiced for ensuring good servicing. We hence come to this conclusion that at least in the context of AC servicing: (i) Awareness is a pre-requisite for action; and (ii) awareness in itself is not sufficient to change actions. The key elements of the GoI awareness generation plan, as highlighted above, are critical and seek to motivate the AC users. Along with this, a critical element needed for behaviour change will be a standardized GoI technician certification process that could differentiate good servicing technician from a below par technician and address the challenge of 'lemons' and adverse selection as highlighted above. As our results in section 3.1 show, even the channel for selecting technician is a channel based on trust, rather than any evaluation of skills that technicians have, and hence a certification system that helps consumers in differentiating between a trained and an untrained technician is a must. This is also a key recommendation of the ICAP, and our findings highlight the criticality of this ICAP recommendation as well. An awareness generation plan on the lines of what has been suggested by us, along with a standardized and robust certification scheme, would together be able to change the incentive structure of AC users in India and lead to significant climate policy benefits for the country.

4.6. Time and money: paying for good servicing practices

As reported in our results, there is a clear trend in the number of people who want to pay less compared to what they pay currently. Only one-third of the respondents were willing to spend more money on servicing. Also, more than three-fourth respondents highlighted the price of servicing as a critical factor impacting the choice of a servicing technician. Along with this, most consumers also do not want to spend more time. Only 12% of AC users were okay with spending more time required for monitoring a servicing being undertaken by the technician. Both time and money are important variables. Good servicing practices take time, and the technicians need to be given a fair remuneration representing their skills as well as the time spent. Only then the environmental and economic benefits related to servicing could be harnessed. The industry, in collaboration with the GoI, should try to optimise the average time spent by a technician for good preventive servicing. In addition, GoI's

awareness generation plan should also include aspects that could enhance the willingness to pay of consumers for a good servicing.

5. Conclusion

From broader awareness related to climate change, policy makers and researchers need to focus on specific actions for mitigating climate change. Behaviour change is going to play an important role in the overall strategy to mitigate climate change. Air-conditioners are expected to account for a significant share in India's residential energy use. As identified in the GoI ICAP, non-adherence to good servicing practices leads to a decrease in energy efficiency as well as higher leakages of high GWP refrigerant gases. Preventive servicing, however, critically depends on the behaviour of end use consumers. Consumer awareness program to change behaviour, hence, is one of the key recommendations of the ICAP.

Our research seeks to inform ICAP's consumer awareness plan. We undertake a detailed survey to understand the knowledge and behavioural aspects of India's AC users and undertake a Randomized Control Trial (RCT) experiment to test the implications of some key messages on consumer's awareness level and actions. The behavioural experiment we undertake is a unique and novel methodological contribution to India's cooling and climate debate. This research is a first-of-its-kind RCT study of Indian consumers' AC servicing practices and feeds directly into the implementation of the ICAP. We find that the average number of preventive servicing undertaken by AC users in India is much lower than required. Our RCT interventions are successful in enhancing high level awareness about the importance of servicing practices, but not in terms of either enhancing awareness at a technical level, or action in terms of increasing the number of servicing practices as the latter two would require an awareness generation program at a massive level, something that only the government or industry could do. Our results clearly suggest that people who know about the economic benefit of regular servicing are more likely to undertake it. We recommend that the GoI's awareness generation strategy should emphasize the economic benefit of good servicing practices.

Also, based on other results related to willingness to pay and spend time, we recommend that the consumer awareness generation plan being considered by the GoI should list the benefits of adopting preventive GSPs, emphasize that regular proactive servicing is a must, highlight that good basic preventive servicing needs at least two hours, motivate AC users to pay higher for good servicing; and emphasize the importance of a good servicing technician.

Our findings also reveal that awareness generation in itself might not lead to change in behaviour. Ultimately the challenge of information asymmetry has to be addressed, and a standardized certification system will be critical for achieving this objective and separating good technicians from sub-par ones. Together, higher awareness of different elements and a robust certification system should lead to a change in the behaviour of AC users and contribute to meeting India's climate policy objectives. Addressing information asymmetry has led to the transformation of market actors in other cases as well, e.g. introduction of star labelling has addressed an important information gap and impacted the way consumers make the decision of AC purchase. The role of Indian industry, as partners of the GoI, will be critical in this transition.

Declarations

Author contribution statement

Vaibhav Chaturvedi: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Wrote the paper.

Arnab Laha: Designed the experiment; Analyzed and interpreted the data.

Apurupa Gorthi: Performed the experiments; Analyzed and interpreted the data; Wrote the paper.

Shikha Bhasin: Conceived and designed the experiments; Performed the experiments.

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Data availability statement

Data will be made available on request.

Declaration of interests statement

The authors declare no conflict of interest.

Additional information

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