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SOCIO-ECONOMIC DETERMINANTS INFLUENCING ADOPTION BEHAVIOR FOR SOLAR HOME LIGHTING SYSTEMS: A STUDY OF THE URBAN HOUSEHOLDS IN PATIALA, PUNJAB

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Abstract:

The purpose of this research is to study the socioeconomic determinants influencing adoption for Solar Home Lighting System (SHS) by the urban households of Patiala, a district in Punjab state of India that has an immense potential for solar energy. A total of 50 subjects (including 25 users and 25 non-users), in addition to three vendors were interviewed, observing COVID-19 appropriate behavior. The present study could not establish a link between the use of SHLS and socio-demographic characteristics namely Age (x^2=0.720), Education (x^2=0.00), Occupation (x^2=2.258) and Family Size (x^2=0.089). Nevertheless, the economic status of users was found to be statistically significantly higher than that of the non-users of SHLS ($p<0.05$). In addition to this, the researcher observed that non-Users could easily afford SHLS, but have been delaying the decision due to lack of awareness, unidentified fear about new technologies and limited knowledge regarding costs versus potential benefits of renewable energy.

Keywords: SHS, adoption, user, non-user, vendors, economic status

1. INTRODUCTION

India has a vast geographical spread with most parts having 300 clear sunny days in a year. The daily average solar energy incidence varies from 4 to 7kWh/m2, depending on the location. The country receives solar energy equivalent to over 5000 trillion kWh per year (Velayudhan, 2003). Harish et al. (2013) said that in 2011, only 9,16,000 rural households used solar energy as their primary source of lighting, representing 0.5% of the total rural households in the country. The diffusion of Solar lighting systems in India since then has progressed at a snail's pace despite the various programs and pilot projects launched in the country. The solar home systems facilitate socio-economic activities and improve standard of living of households, especially of women living in the area and improved environmental standard by reducing household pollution resulting from use of traditional sources of energy such as kerosene. In addition to scaling up solar technology, an institutional framework with quality leadership and active participation of NGOs and other community level organization is necessary to link markets and policies effectively and enhance households' inclination towards greater use of this energy (Mishra, 2016).

Solar photovoltaic (PV) technology offers an instantaneous lighting solution for

urban as well as rural households with limited or no access to electricity (Venkateshwaran, 2018). Given the potential of solar PV technology, the Indian government has launched various solar PV initiatives since the 1980s, including the Jawaharlal Nehru National Solar Mission in 2010. Despite these efforts, penetration of solar PV technology remains below 1% in India (MOHA, 2011). Between 2010 and 2016, only 996,841 solar lamps and 1,396,036 solar home lighting systems were installed through various programs (MNRE, 2017). According to the 2011 Census for Data from households by the main source of Lighting, out of the 5754 households using solar lighting in Punjab, 4431 households belonged to the rural areas and only 1323 to the Urban areas in the state. To sum up the background of the study, it is suggested that most of the studies related to solar lighting in households have been done for rural areas. Hence, the present study has been conducted with a specific focus on Urban households and understanding the limitations for the urban households in not accessing the solar energy up to its full potential despite its benefits.

CONCEPT OF SOLAR HOME LIGHTING SYSTEM

Solar Home Lighting System or SHS is a system powered by solar energy which uses solar cells that convert solar energy (sunlight) directly into electricity for lighting up the home as well as powering the electronic appliances. The electricity is stored in the batteries and is used for the purpose of lighting whenever required. It is economical, non-polluting and no-maintenance means of producing electricity.

The system consists of

- A Solar PV Module (Solar Cells)
- Charge Controller
- Battery and
- Lighting System (lamps & fans).

The solar module is installed in the open on the roof/terrace of the house - exposed to the direction of direct sunlight and the charge controller and battery are kept inside a protected place inside the house. It is highlighted in Figure 2 below. The operational time depends upon the capacity of the system. However, most systems are designed to give a daily working time of 3-4 hours with a fully charged battery. The system provides for buffer storage for 1-2 non-sunny/cloudy days.

SOCIETY AND TECHNOLOGY: THE CASE OF SOLAR HOME LIGHTING SYSTEM (SHS)

In recent years, solar technology has achieved unprecedented results on several arduous tasks. Nevertheless, inadequate sociological understanding of solar home lighting system limits the adoption scenario, even in urban households of our Nation. A number of factors can be attributed to the adoption pattern of solar home lighting system amongst the households- Economic factors, Environmental factors and Social Factors. This study is an endeavor to examine the difference in adoption behavior of users and non-users and thereby addressing the following question:

Does technology influence the society or society brings the technological change?

Technology is the application of reason to the technique that are useful within the society (Dorf, 2001). Technology is socially (and politically) constructed; and society (including politics) is technically built and consists of sociotechnical ensembles (Bjiker, 2015). Historically, the success or failure of a particular tool or device was determined not simply by the quality or utility of the invention itself, but by a range of social factors such as the degree to which society is open to change or adjust and the social status of the inventor (Ede, 2019). Every technological innovation has a societal aspect to it. Society has a cyclical co-dependence on technology and thus; Technology and human life cannot be separated. Technology and society are intricately, and reciprocally connected (Bauchspies, 2005). Human beings or the society uses technology; it depends upon technology in their daily routine life and their needs and demands for technology keep on rising. The 'need for survival' has made humans use technology to travel, to communicate, to do business, to learn, and to live in comfort. The whole Civilization was a product of technology (Menon, 2010).

Humans defying the natural order and exploiting the non-renewable resources has led to the large-scale depletion of the non-renewable resources of energy causing melting of ice caps, serious floods, droughts, storms, thus, damaging the balance of the ecosystem. The rate of economic growth and technological development has brought industrial society to its environmental limits (Johnson, 2021). As many environmentalists are vouching for Alternative Technology, a simple switch of technology would not be sufficient and we need an alternative society as a base for the alternative technology (Johnson, 2008). According to Andrew Ede, social flexibility is an important condition for high rates of innovation in a society (Ede, 2019).

Artefacts—things humans have made are involved in most of the ways human beings relate to each other (Mackenzie, 1999). Thus, Solar panels, solar cookers, solar geysers and Solar Home Lighting System are only artifacts or a products of human construction and craft, and are thus the physical component of technology, but they are not the technology itself. It is only when the artifact is brought to use that it becomes something more than a collection of matter (Ede, 2019). The introduction of any new technology results in winners and losers (or those who manage to benefit or exploit a new technology and those who do not). The winners are able to harness the technology and are the ones who share the history of the technology. The societies that fail to understand the problems of their technologies, or who are unable to overcome real-world problems with workable solutions (whether technological or otherwise) get erased from history, leaving only archeological remains (Ede, 2019). Our current global society is not exempt from this condition. (Ede, 2019). The idea of technological determinism which means the idea that technology drives social change and that technological change is inevitable. So, on the one hand, we recognize that new technologies come from inventive activities informed by social needs or interests that reflect the views and social position of specific social groups. On the other hand, we also recognize the subjective feeling we all have to one extent or another, that we are slaves to the machines around us. Technology sometimes seems to be forced upon us in our daily lives. In the face of new technologies, we seem to be having only two choices – take it or leave it (Bauchspies, 2005).

The energy ladder model proposes that households transition from lower order fuel sources (e.g. kerosene) to higher order sources (e.g. electricity) as one's income increases (Lay,

2013). Leach, 1992 introduced the energy ladder in urban settings, articulating the main driving forces in energy transitions, household preferences, and constraints on transitions. Scholars have continued to study the determinants of energy transitions for lighting and cooking, with an emphasis on key demographic variables such as income, price of the fuel, head of household gender, and education. A 'solar energy ladder' progresses from small or pico-solar products like lanterns to solar home systems, to microgrids (or minigrids), and finally to grid access. Each stage on the ladder is associated opportunities for new appliances and increased energy consumption (Chattopadhyay, 2015).

Pinch and Bijker (1984) gave the concept of Social Construction of Technology (SCOT), which is a developmental process of a technological artefact (an object made by human being) and is described as an alternation of variation and selection. Interpretative flexibility refers to the way in which different relevant social groups of people involved with a technology can have very different understandings of that technology, including different understandings of its technical characteristics (Mackenzie, 1999). Technological Frame structures the interactions amongst the members of relevant social groups and shapes their thinking. In the context of Solar Home Lighting System, we have two social groups- the Users and the Non-Users of this technology. For Bijker and Pinch, symmetry means avoiding explaining the success or failure of technologies by whether or not they work. For them, 'machines work because they have been accepted by relevant social groups' (Bijker 1995, 270).

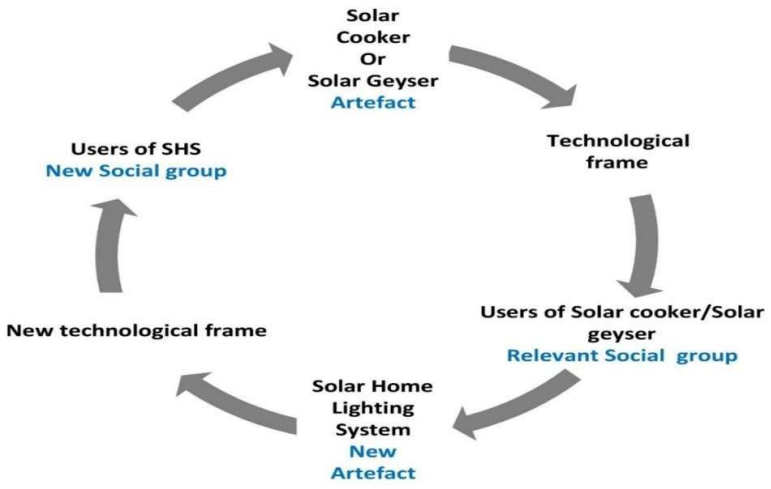


Figure 1: Cyclical relationship of an introduced artefact within its technological frame (*The figure has been adapted from Bjiker, 2015 in his work "Technology, Social Construction of")*

When relevant social groups interact typically one meaning of the artefact gains dominance and it stabilizes. At the end closure occurs and interpretive flexibility vanishes. Thus, the introduction of any new artefact in the society is a seamless web of technology and society, until it reaches its stabilization in a cyclical movement when a technological frame is built up 'around' and artefact as highlighted below. The model has been given by Wiebe E. Bjiker in his research "Technology, Social Construction of" in 2015.

OBJECTIVES

Through this study, the researcher has the broader objective of working on Clean energy, Green Social Work and the lag in achieving the United Nations Sustainable Development Goals by 2030, particularly:

Goal 7- Affordable and Clean Energy;
and Goal 11- Sustainable Cities and
Communities

The researcher aims to discuss the current scope of Solar energy as clean energy in Urban households and how further it can be disseminated. The researcher would further give recommendations on the basis of our observations on how to overcome the current challenges in the maximum dissemination of solar energy. For carrying out the study the research attempts to:

1. To describe the socio-economic status of the users and non-users of Solar home lighting system.
2. Iterate the reasons from the respondents (both users and non-users) of choosing (not choosing) the Solar products.
3. People's reaction to User's decision of having the Solar Home lighting system.
4. To understand the sources of information and the process of getting the solar product at home.
5. To know the experience of the users about the performance of the solar product.
6. To review the literature and policies of the government on the product.
7. To discuss with the technical service providers in the city and summarizing their views and experiences.

2. METHODOLOGY AND RESEARCH DESIGN

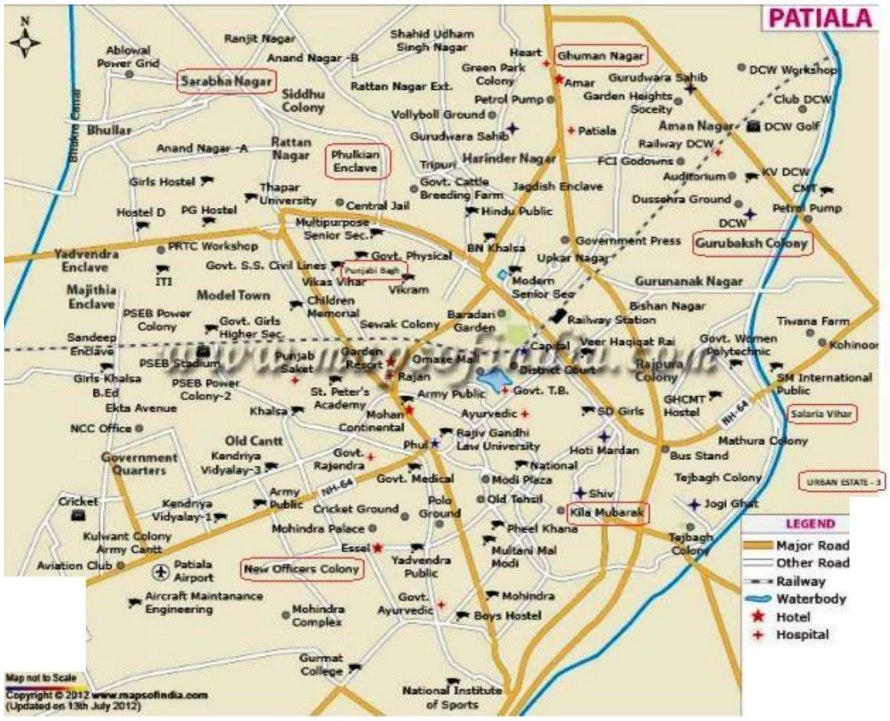
The approach followed in present study was descriptive in nature, as it examines the socioeconomic determinants - such as age, occupation, education, family size, annual income, employment nature - for the use of Solar Home Lighting System. This cross-sectional study is based on field survey. The cross-sectional study is a non- experimental, one time or at a point of time study of all individuals in a representative sample of a specific population (Mahajan, 2010). Users as well as non-users and vendors related with Solar Home Lighting System have been examined through field survey in this study to understand the adoption of SHS through a sociological lens.

2.1 STUDY POPULATION

The study population comprises of urban households of the State of Punjab, in the city of Patiala, including users and non-users of Solar Home Lighting System. Users were the individuals using the SHLS from about not less than six months and residing in the urban households' locality of Patiala. Non-user households were the immediate neighbours of the users and currently not using this particular lighting system. Additionally, the study population included the vendors who are the dealers of the SHS and have their business centered in the city of Patiala.

2.2 SAMPLING METHOD

A multistage random sampling technique was used for the data collection. As the name implies, this method refers to the sampling procedures carried out at several stages using random sampling techniques (Mahajan, 2010). In the first stage, district Patiala was selected



from 29 districts of the State of Punjab, India. The entire target population of city of Patiala is divided into 57 wards according to the 2011 census, therefore, a total of 5 wards – approximately 10% of total no. of wards - were selected randomly, as the second stage of sampling. Five user and five non-user households were selected randomly from each selected ward to examine the socioeconomic determinants for the adoption of Solar Home Lighting System by the urban households. The non-user households were the neighbors of the user households, currently not using the solar home lighting system.

Figure 2: Map of Patiala city with the highlighted areas of research

(Source:https:1/www.mapsofindia.com/mapslpunjablpatiala.html)

2.3 SAMPLE SIZE

50 urban households including 25 users and 25 non-users of solar home lighting systems from five out of 57 wards of Patiala were included in this study. In addition to this, three vendors also participated in the study. The researcher got the contact details of theses vendor through the users.

2.4 SOURCES OF DATA COLLECTION

There are mainly two sources of data collection prevailing in Social Work Research practice: 1) Primary source of data- Structured interview and the questionnaire were the two

major sources of data collection in the present research. The researcher asked the questions in a face-to-face contact to the respondents. Keeping the main objectives of the study in mind, three kinds of self-structured questionnaires were used to obtain the necessary information from users, non-users and vendors. The researcher interviewed the Head of the Family. If the household was female headed, the respondent was the female. If the household was male headed, the researcher interviewed both, the male and one adult female in the family who was active in decision making process.

2) Secondary source of data- The digital sources were used to get different scholarly articles, daily newspaper, books, magazines, official survey reports, etc. to help gather relevant information on the research topic.

2.5 ANALYTICAL FRAMEWORK

The information provided by participants became the raw data for the conducted study. This raw data was entered into Microsoft Excel in order to facilitate analysis. Descriptive analysis was used to analyze socio-demographic data. The inter-relationship between various socio-economic factors, constraints for adoption of Solar Home Lighting System and adoption behavior of user as well as non-users, was analyzed by using Chi square test and Mann-Whitney U tests. SPSS 7.5 was used to employ these statistical techniques. The findings of the study have been presented in tables and graphs in chapter III.

2.6 LIMITATIONS

The researcher observed the following limitations while carrying out this study:

- ❖ The sample size of the study was small and was restricted to 50 subjects including 25 users and 25 non-users of Solar Home Lighting Systems.
- ❖ The study was confined to a district of Patiala in a State of Punjab, India.
- ❖ The researcher studied the urban households only.
- ❖ Solar Home Lighting System and not any other source of solar energy was studied as a form of clean energy.
- ❖ Many of the questions related to adoption behavior for SHLS were subjective in nature.
- ❖ The global pandemic due to COVID-19 itself was a great limitation as it posed a serious challenge to the researcher in terms of personal visits, face-to-face interview and travel to the various households as well as the vendors.

3. RESULTS AND DISCUSSION

3.1 SOCIODEMOGRAPHIC PROFILE OF USERS OF SOLAR HOME LIGHTING SYSTEM

The average age of users was 53.64 years with the youngest one being 35 years old whereas the senior-most user had attained 77 years of age. Considering the age wise categories, 11 respondents were young; on the other hand, 14 were old. 12 out of 25 respondents were males whereas 13 were females. All of the respondents were married. 21 users were either graduates or even post-graduates with only 4 respondents not reaching the level of graduation. The researcher examined that maximum number of users (14) were working whereas 6 were non-working. It was further observed that 5 respondents had retired from

their respective jobs.

3.2 SOCIODEMOGRAPHIC PROFILE OF NON-USERS OF SOLAR HOME LIGHTING SYSTEM

The researcher identified that mean age of non-users was 47.2 years, with minimum age being 27 years and maximum 74 years. Out of 25 respondents, 14 were young whereas 11 were old. 18 of them were males and seven females. Their marital status indicated that all were married with only 1 respondent separated from the spouse. Most of the respondents (21) had completed their graduation with only 4 respondents having education more than secondary level but less than graduation. 19 individuals, in the category of non-users, were working whereas 3 were non-working. An equal number (3) of non-users were retiree.

3.3 ASSOCIATION BETWEEN SOCIO-DEMOGRAPHIC STATUS AND THE USER OF SOLAR HOME LIGHTING SYSTEM

This section deals with the socio-demographic status of respondents of the current study. The researcher intended to explore individuals, belonging to which age range, use the newer concept of solar energy, Are they young or old in age? Is education required to determine the use of SHLS? Is there any association between work profile and the usage of SHLS? Could households with bigger family size adopt SHLS? To get the reliable answers of these research questions, all of the respondents were categorized into young or old; up to graduate or graduate & above graduate; working, retired or non-working; and small family size or big family size. Figure 3.1 to 3.4 exhibits the various categories of users as well as non-users of SHLS with respect to age, education, occupation and family size.

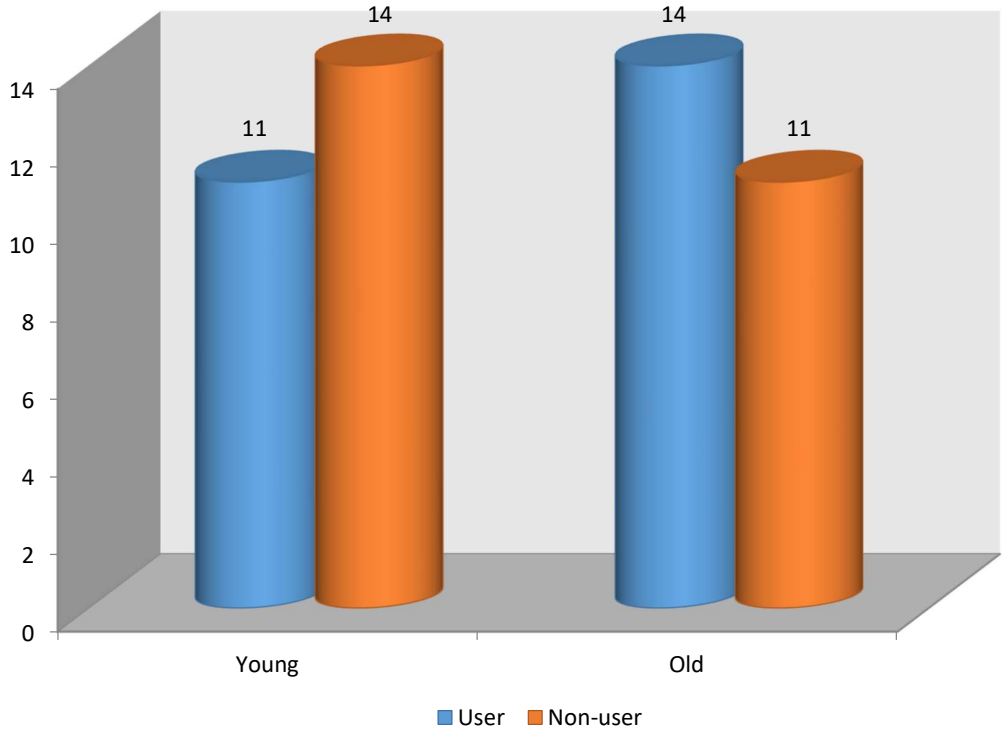


Figure 3.1: Association between age and the use of Solar Home Lighting System

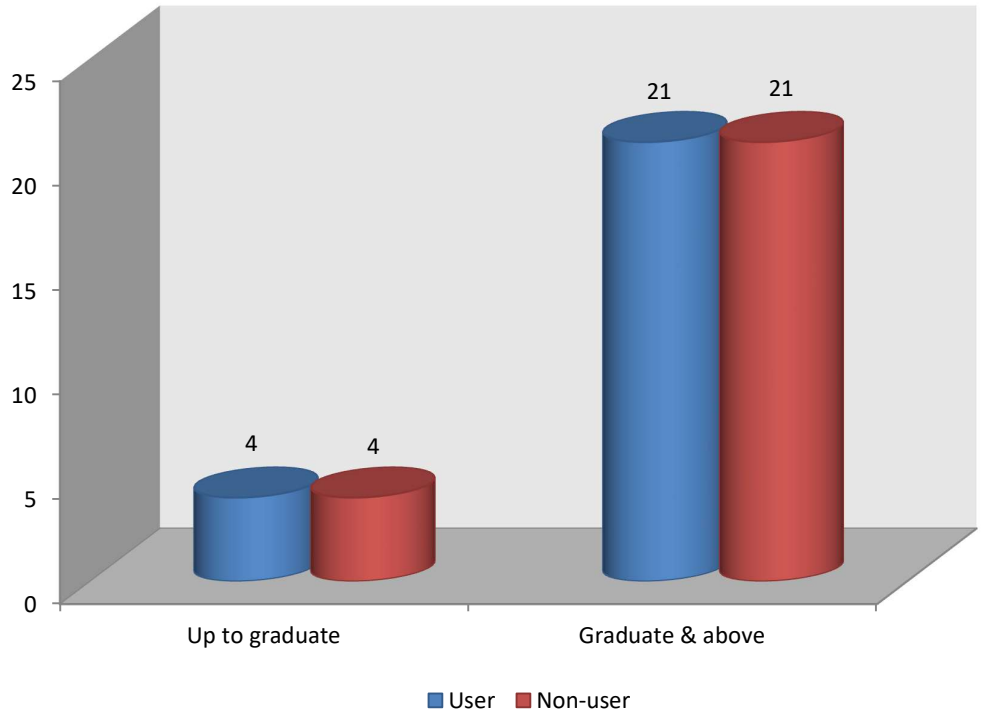


Figure 3.2: Association between education and the use of Solar Home Lighting System

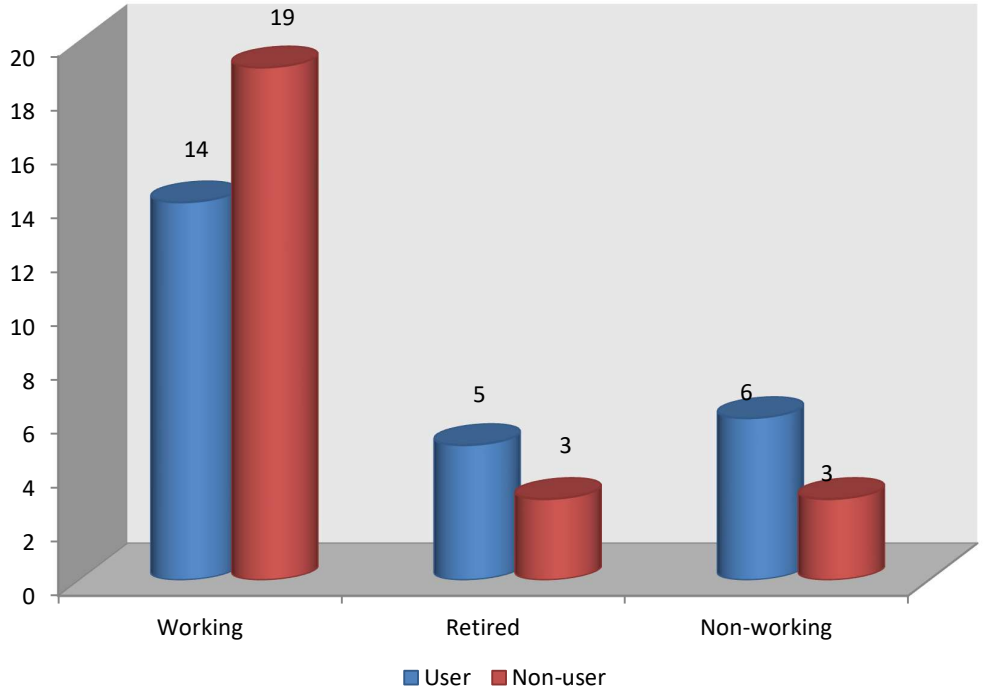


Figure 3.3: Association between occupation and the use of Solar Home Lighting System

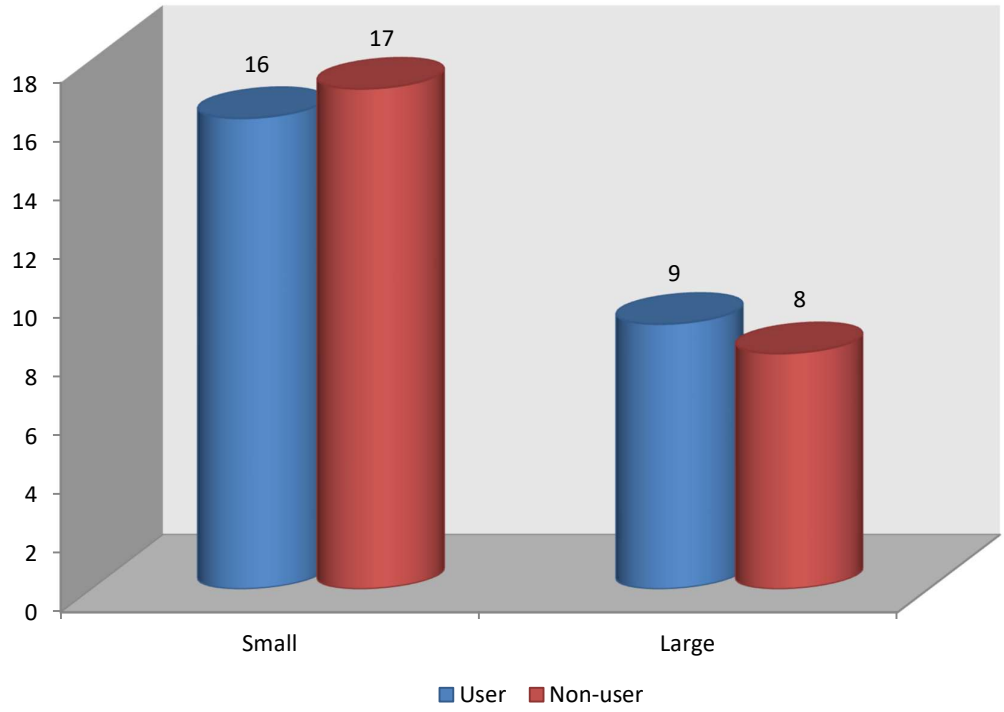


Figure 3.4: Association between family size and the use of Solar Home Lighting System

Table 1: Association between socio-demographic characteristics and the use of Solar Home Lighting System

Variables	Categories	Users (n = 25)	Non-users (n = 25)	Pearson Chi-Square	Significance
Age	Young	11	14	0.720	0.396
	Old	14	11		
	Total	**25**	**25**		
Education	Up to graduate	4	4	0.000	1.000
	Graduate &	21	21		
	Total	**25**	**25**		
Occupation	Working	14	19	2.258	0.323
	Retired	5	3		
	Non-working	6	3		
	Total	**25**	**25**		
Family size	Small	16	17	0.089	0.765
	Large	9	8		
	Total	**25**	**25**		

Table 1 displays the association between the socio-demographic status of the respondents and the use of Solar Home Lighting System. Chi square analysis indicated that there is no statistically significant association between the use of SHLS and the socio-demographic characteristics namely Age, Education, Occupation and Family Size. This indicates Education or Occupation of the families is not one of the significant factors in deciding the adoption of solar home Lighting system by the household. On the contrary, Velayudhan (2003) suggests that the early adopters of the solar lantern are of higher social status, reflected in their occupation, income and education. Nevertheless, the observations of the researcher indicate that SHLS could be used by the individuals of all ages – young or old; graduates or undergraduates; working, non-working or retired and households having small or large size.

3.4 COMPARISON OF THE ECONOMIC STATUS OF USERS AND NON-USERS OF SOLAR HOME LIGHTING SYSTEM

Table 2: Economic status of Users and Non-users of Solar Home Lighting System

Variables	Users			Non-Users (Mean±SD)			U	P
	Mean±SD	Min	Max	Mean±SD	Min	Max		
No. of Sources of income	1.28±0.54	1	3	1.28±0.54	1	3	312	1.000
Business	0.2±0.4	0	1	0.24±0.43	0	1	300	0.735
Agriculture	0.2±0.4	0	1	0.28±0.45	0	1	287.5	0.512
Employment	0.88±0.33	0	1	0.76±0.43	0	1	275	0.274
Nature of employment	2.72±1.46	1	5	2±1.19	1	5	220.5	0.061
Annual family income	2.56±0.58	1	3	2.2±0.64	1	3	218.5	**0.042***
No. of vehicles	2.12±0.88	1	4	1.48±0.65	1	3	179.5	**0.005***
LCD	1±0	1	1	0.88±0.33	0	1	275	0.077
AC	1±0	1	1	1±0	1	1	312.5	1.000
I phone	0.68±0.47	0	1	0.6±0.5	0	1	287.5	0.560
Microwave oven	1±0	1	1	0.92±0.27	0	1	287.5	0.153

*$p < 0.05$

Table 2 displays the comparison of the mean values of the Economic variables of Users and Non-users of Solar Home Lighting System. Mann-Whitney U test analysis indicated that there is statistically significant difference in the Annual Income of Users and Non-Users implying that the Users were more financially stable than the non-users (U= 218.5 at $p < 0.05$). The number of vehicles was also statistically greater in number for the Users than the Non-Users (U=179.5 at $p < 0.05$). This is in line with the study by Acker and Kammen, where Wealthier Kenyan families adopted SPV systems as they had the resources to invest in these systems for their homes (Acker and Kammen, 1996). Harrington et al (2020) in their research ―Variation in rural household energy transitions for basic lighting in India‖ have also found out that Adoption factor for 75% of their respondents was Pricing

i.e. affordability and financing. People cited pricing and payment options as a major factor influencing their decision of adoption of SHS. The Capacity of the household is also a factor for the retention of SHS i.e. the Users ability to meet the household needs after investing in SHS, and waiting for its payback period.

3.5 REASONS FOR ADOPTION OF SHS BY USERS

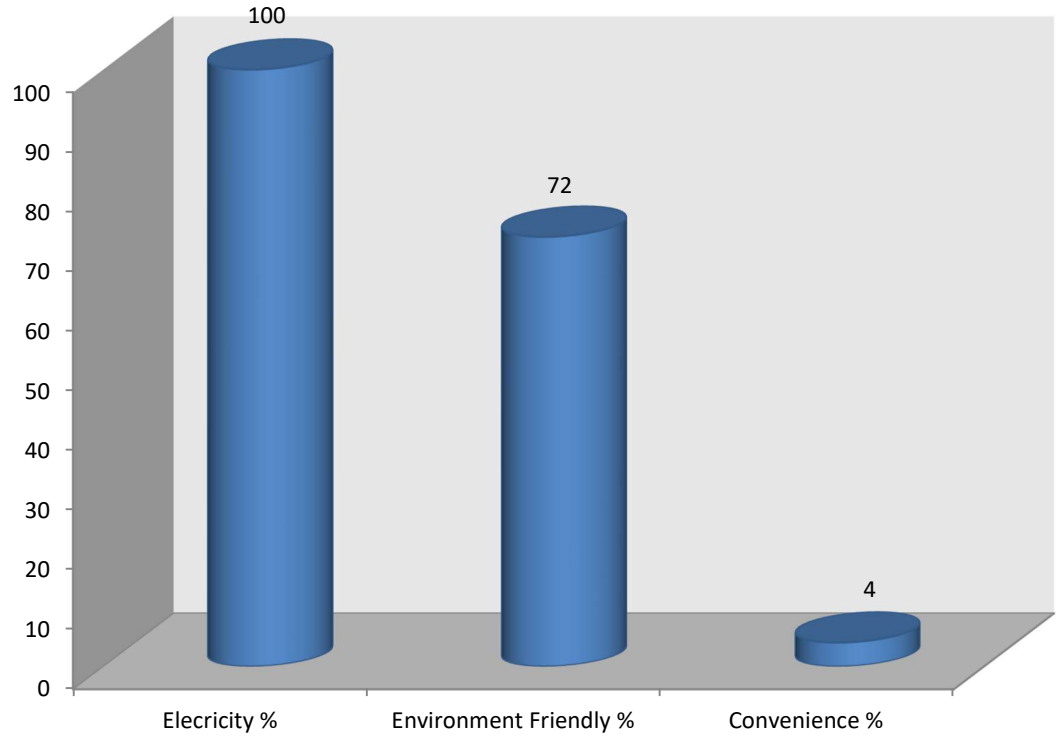


Figure 3.5: Distribution of Users according to the Reasons identified for adoption of SHS

Multiple reasons were given by the Users for adopting SHS. Amongst the reasons for adoption for SHS as enquired amongst the users, 100% of the Users gave the reason of saving Electricity bills as the prime reason for adopting SHS. The same was verified with the vendors, who said that all their clients came to adopt SHS as they heard that adopting SHS, reduces their electricity bills. 72% of the Users also gave the reason of adopting SHS as being an environment friendly option. 4% cited convenience as the reason for adopting SHS. They said operating SHS was very convenient and easy and that not much maintenance was needed after its installation, hence being a convenient method to produce electricity.

3.6 IDEAS THAT INFLUENCED ADOPTION OF SHS FOR USERS

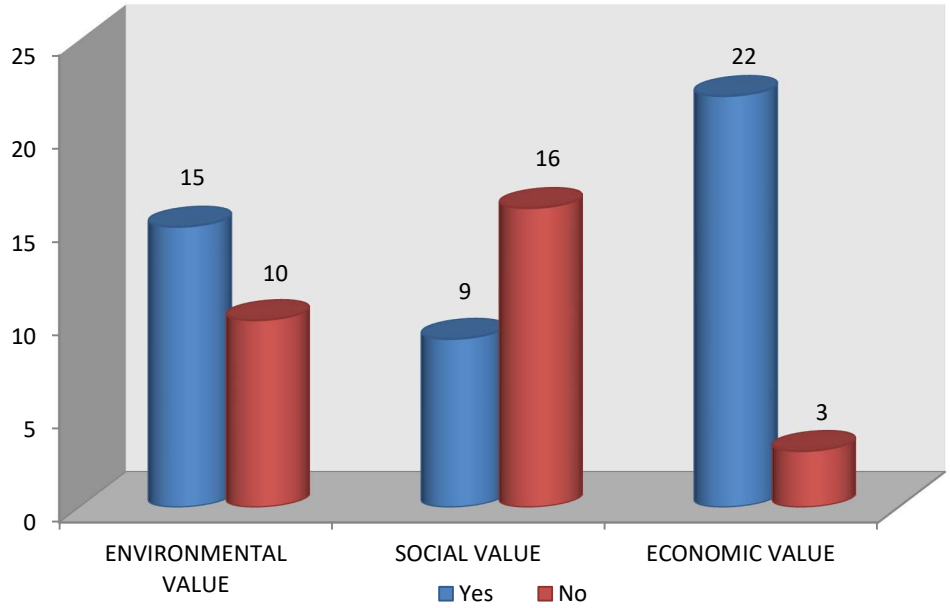


Figure 3.6: Distribution of Users according to the Ideas that influenced adoption of SHS

22 Users emphasized that they had adopted SHS due to its economic value i.e. it would help them save their electricity charges. Out of the same 22 Users, 9 of them also agreed to mentioning that they did adopt SHS due to its social value, i.e. they were influenced by their friends, families or peers and they decided to adopt it, as they could afford it, and thus didn't wish to remain behind on latest solar technology amongst their peers. Our results align with the energy ladder model (Lay et al, 2013) which proposes that households transition from lower order fuel sources (e.g. kerosene) to higher order sources (e.g. electricity) as their income increases and they move up the ladder of socio-economic status. Moving up the solar energy ladder scholars suggest that households will progress from small-scale solar lanterns, to home systems, then to connections to mini or micro grids, and if available, eventually connect to the grid (Chattopadhyay, 2015), incrementally adding appliances and capacity as needed or feasible Each stage on the ladder is associated opportunities for new appliances and increased energy consumption, and thus the solar energy ladder theory can be expanded further to see how these decisions to adopt newer technologies are linked to household budgeting and decision making.

3.7 SOURCES OF INFORMATION OF SHS FOR THE USERS

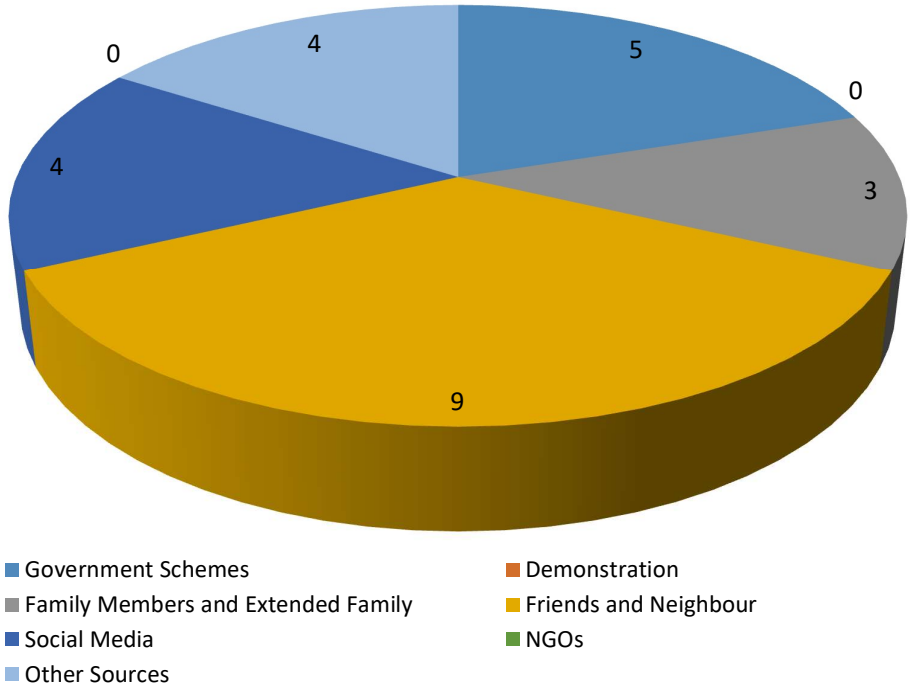


Figure 3.7: Sources of Information of SHS for the Users

"Communication and diffusion of innovation" theories suggest that the acceptance of innovations is influenced by the individualities of the innovation and also the whole development process by which the communication takes place in the community. The acceptance of an idea by an individual, follows a process of awareness, knowledge and action. The information provided from different sources creates awareness and knowledge about the new technology which may lead to adoption. The communication flows quickly through the community and therefore social network is an important influence on adoption (Velayudhan, 2003). This is in alignment with our findings as maximum users i.e. 9 out of 25 said that they had adopted the technology after hearing about its benefits from their friends and neighbors. Friends and neighbors are also used to check the product performance, as SHS is a reasonably high valued and infrequently purchased product. The strongest means of increasing awareness for new purchases is for households to see the technology in use, followed by peer influence. Seeing technologies 'in use' indicates a more passive increase in awareness, while peer influence indicates more active efforts to persuade their peers to purchase or connect to a certain new type of technology (Harrington, 2003).

3.8 REDUCTION IN ELECTRICITY BILL PERCENTAGE FOR USERS

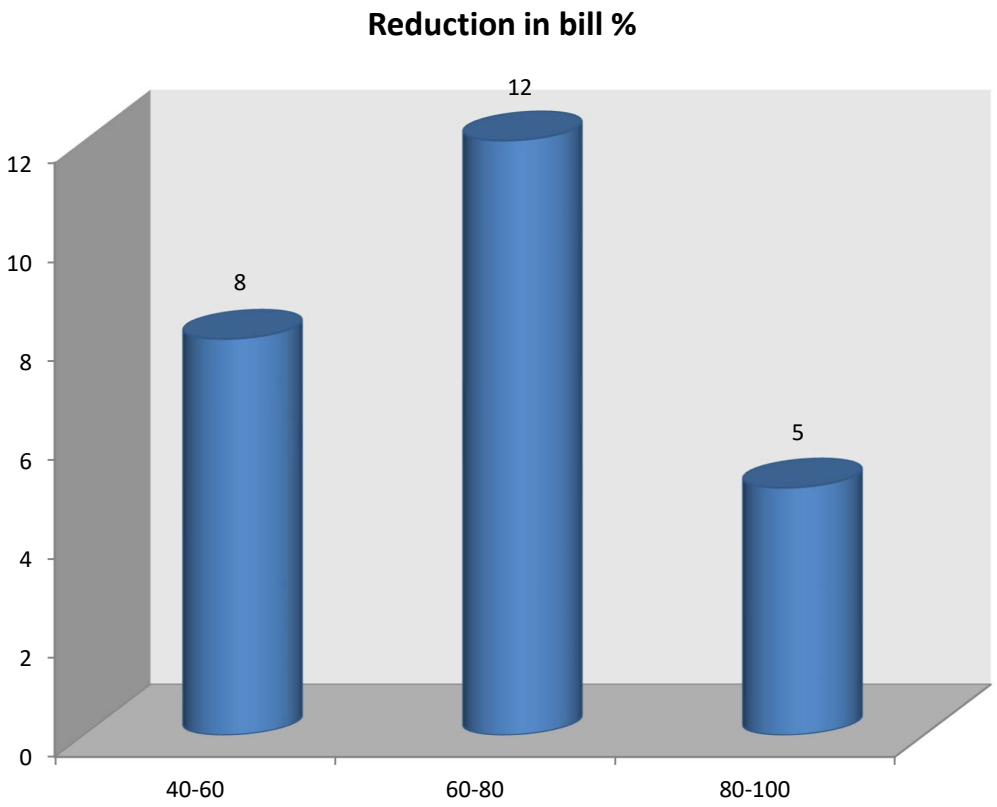


Figure 3.8: Reduction in Electricity Bill % for the Users

5 Users said that their electricity savings were in the range of 80-100%, 12 said they were in the range of 60-80% and the remaining 8 said they were in the range of 40-60%. One of the Vendors however, while discussion with the trainee completely disagreed to the Users claims that their saving was in the range of 40-60%. He said that he can say this with a 100% guarantee that SHS bring minimum 80% of savings on one's electricity bills. The trainee didn't have the exact data of the bills of all the Users and hence cannot verify the claim.

3.9 LEVEL OF SATISFACTION EXPERIENCED BY USERS

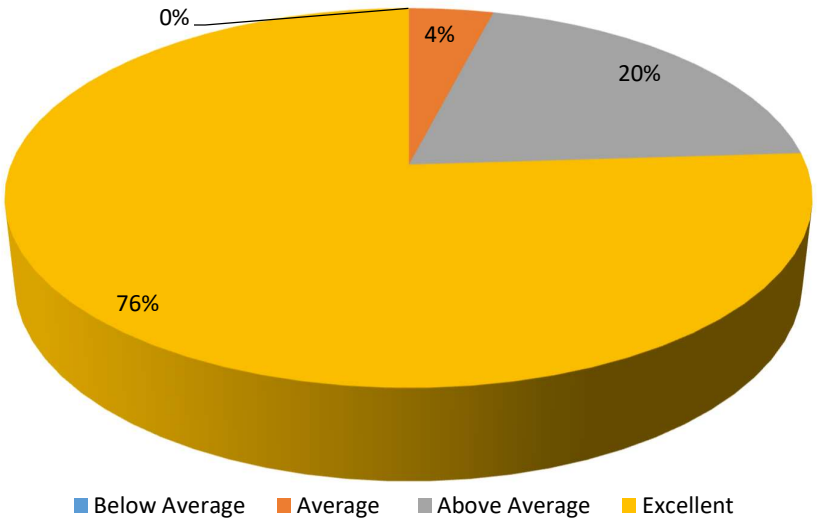


Figure 3.9 Percentage distribution of Users according to the level of satisfaction experienced

76% of the Users rated their level of satisfaction as Excellent. 20% rated as above average and 4 % as average. Additionally, maintenance cost for the SHS was rated Low for all the Users. They are well in line with the research by Palit and Shukla (2003) where the major conclusion of their study is that the solar energy technologies are not completely maintenance-free and regular 'location specific' maintenance plays an important part for sustainability of the systems. 60% of the SHS could be made functional by minor rectification efforts such as charging of battery, replacement of switches and or luminaries etc. The Users in our study also said that the solar panels need to be cleaned once or twice a month to avoid any dust accumulation and thus it doesn't hamper the efficiency of SHS. All the 25 Users also mentioned that there has never been any major technical glitch since they have installed the SHS. The same was confirmed by all the three vendors as they too agreed that they have got no clients bringing any major technical complaints regarding SHS. The 20% Users who rated their level of Satisfaction as above average and the 4% as average gave reasons such as

- PSEB delays the installation of the SHS at the households by months as they feel that their income would get reduced with more households getting lesser amount of bills. There is no proactivity on their part in helping with the installation.
- The subsidies for SHS have also been delayed by months now, since 2019.
- The system of debit/ credit of electricity was not very clear to many of the Users and were just blindly following the bills they received.

3.10 DISCUSSION OF ADOPTION BEHAVIOUR OF NON-USERS

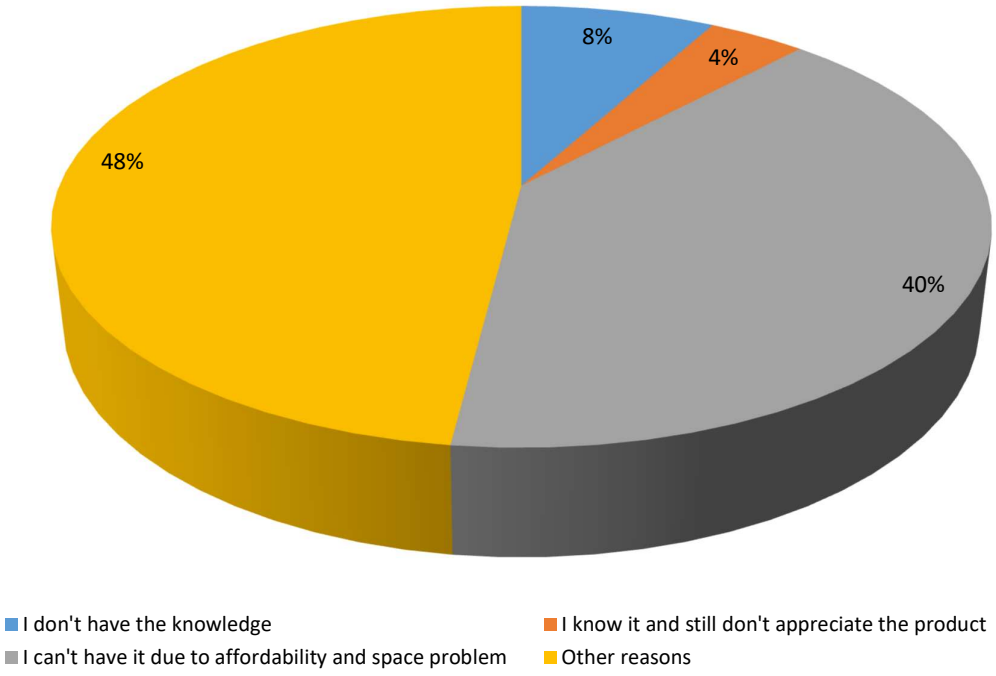


Figure 3.10 Percentage distribution of Non-Users according to their adoption behavior pattern

Amongst the Non-Users, the reasons for not adopting the SHS included No knowledge about the product (8%), they have knowledge but are clearly ignoring its benefits and not appreciating the product (4%), can't have it due to affordability and space problem on their roofs (40%). 48% of Non-Users did have knowledge about SHS but gave other reasons for delaying its adoption. They included procrastinating the decision of adoption fearing new technology, not having proper awareness about the billing system of SHS, no idea about its efficiency and maintenance charges, they are gathering knowledge and taking feedback about SHS and would soon be adopting it in future. The researcher could gather after interaction with the Non-Users that this 48% category of Non-Users could easily afford SHS, but have been delaying the decision due to lack of awareness or fearing change with a new technology coming into their homes. Limited community awareness and a lack of information on technologies, costs and potential benefits of renewable energy pose serious barriers to the growth of solar technologies. (Yadav, 2019).

3.11 INTERACTION WITH SHS VENDORS

The researcher spoke to four vendors out of which three of them gave their consent to participate in the study and undertake the research inquiry, who were willing to share their experiences with the Users, their technical encounters with the solar Home Lighting System, their take on government policies regarding the usage of solar energy and the challenges they faced while entering this business and establishing themselves. The three narratives presented are from the vendors residing Patiala and are excerpt from interviews conducted, two of them telephonic and one face to face by the researcher with them. Access to the local vendors and services influence the adoption of new and repair of existing technologies. Building awareness of technologies and services from peer recommendations or availability in local shops (and therefore recommendations by local vendors) was influential in purchase decisions for SHS. This research suggests that purchases were influenced more by one's personal experience or exposure to a new technology i.e. the use of some other solar energy operated appliance like solar geyser, solar cooker etc. rather than indicators including quality certifications or warranties, and thus, with the increase in household's annual family income they readily shift to a newer technology alternative, sufficing the term Solar Energy Ladder. Also, clearly the Non-Users can also afford SHS but are not installing it due to the fear of adopting new technology and resisting the change in their current household electricity supply. Many non-users also doubt the intentions of PSEB and that they are not clear of the debit and credit of units done by the same. Thus PSEB needs to make the bill processing very clear and transparent. The city Vendors are almost relying on only Referral clients and not going beyond that for any promotions or publicity of their business. The Vendors can also do more promotions for SHS, collaborate with NGO's and widen their customer base.

4. SOLUTIONS AND RECOMMENDATIONS

The researcher identified the problems the Users and the Non-Users were facing in the successful dissemination and the working of SHS. The policy as well as the technological and financial constraints notwithstanding, the region of Punjab and the city of Patiala offers vast scope to harness the rich solar energy for improving the quality of life of the urban population. Given the considerable investment made in implementing the various solar energy

schemes in the region, it would be a worthwhile exercise to incorporate some changes in the present planning and implementation process to effect the desired impact.

4.1 The Dissemination approach of the current implementation process needs a complete makeover of the conventional approach to achieve maximum effectiveness. A '*bottom up'* approach entailing government's contribution for overall policy, R&D, technical and financial support with the primary responsibility of planning, implementation, maintenance and management on Municipal Corporations, PSEB, PSCPCL, CBOs/NGOs or the community would ensure greater success of the programmes. The involvement of the urban community during the planning and implementation phase of a project would also ensure better understanding of the technology by the community which in turn would enhance its acceptability. Grassroots experience with solar programme shows that cluster approach makes follow- up and maintenance much easier. For electrification projects, micro projects with communities as 'active partners' will be most suitable and sustainable. Government in collaboration with the environmental NGO's should bring more awareness amongst the urban communities regarding the benefits and working of SHS using social media and awareness campaigns to reach a wider target audience.

4.2 Financial support is critical to the sustainability of a renewable energy programme, and hence innovative financing packages including flexible credit facilities need to be extended to agencies/institutions and potential users to promote the greater use of solar systems in the city of Patiala. For communities that cannot afford any modern device at any cost with their current livelihood conditions any solar energy technology scheme has to be linked with their income generating activity according to the Solar Energy Ladder. Further, instead of providing direct/flat subsidies on the devices, beneficiaries may be given incentives for using the system.

4.3 Competitive domestic manufacturing of SHS is required in India. We do have a handful of companies like Tata Solar, Vikram Solar, Luminous, Panasonic doing some prodigious manufacturing in the field of Solar Power, but still we need more indigenous companies to come up for the manufacturing of solar products.

4.4 Establishing an electronic project repository including an interface for private enterprises to establish a robust and reliable mechanism to track electricity generation (off-grid) and consumption (electricity access indicators at the household level) for transparent monitoring and reporting of projects and assessment of their impact, as well as explaining the credit and debit system by PSPCL for the public would build more trust amongst the people.

4.5 Strengthening of the Punjab State Power Corporation Limited with technical and domain experts and the adoption of modern management practices to ensure appropriate technology deployment and promote cost-effective and centralised project planning, approval and coordination.

4.6 Introducing the communities to Wall-mounted model of SHS could be a solution for those households who have space problem on their roofs and still want to make the use of solar energy.

Further the problems identified for the Users, Non-Users and the Solutions recommended have been summarized in the chart prepared below. It has been adapted from the 'Social Construction of Technology' model, 1984 by Pinch and Bijker.

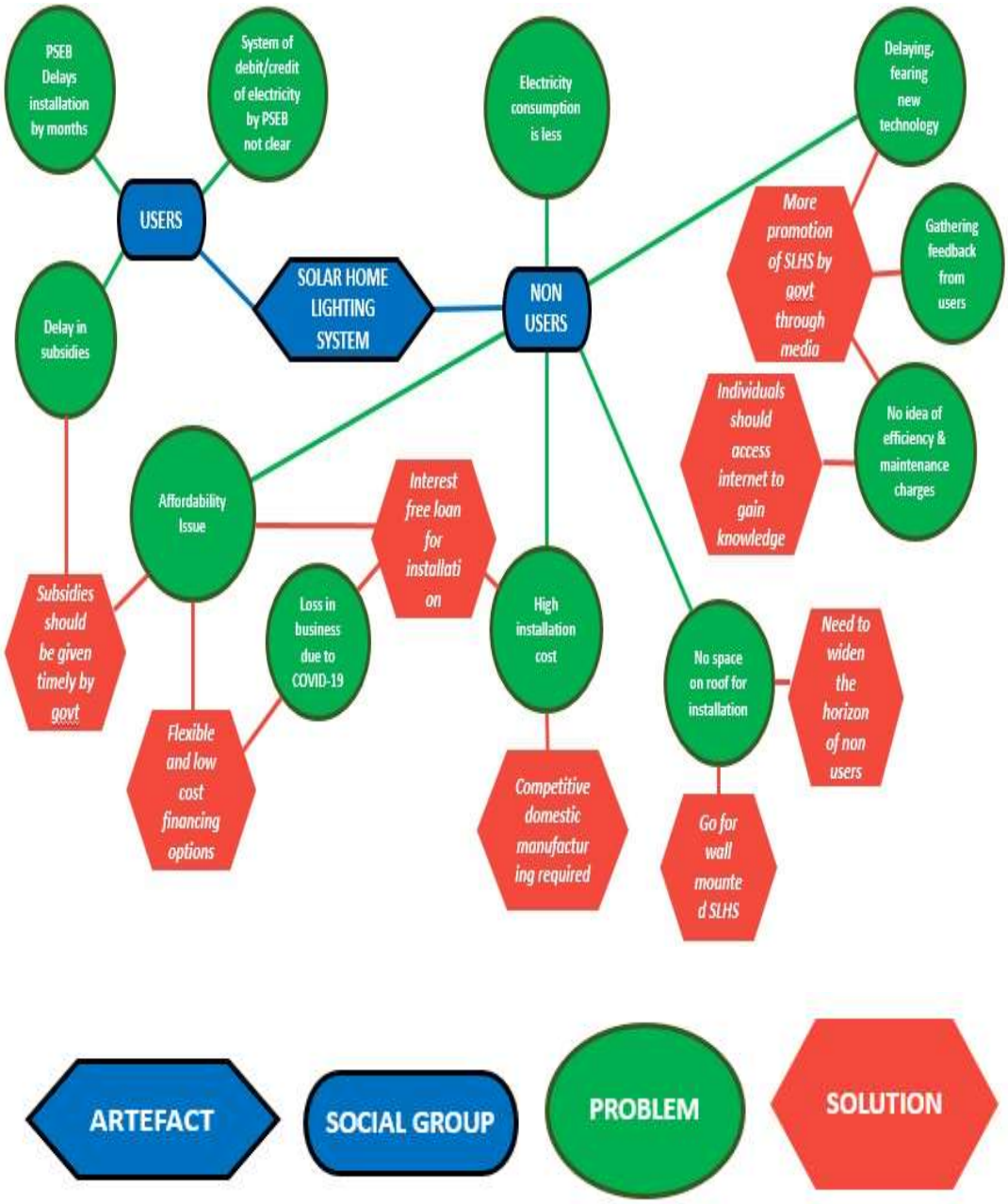


Figure 4 Problems and Solutions identified for Users and Non-Users in the Development process of SHS. The chart is based on the SCOT model by Pinch and Bijker, 1984

5. RELEVANCE FOR SOCIAL WORK PRACTITIONERS

The study is of significance to the Green Social workers who mobilize individuals, groups and communities in affirming their environmental rights and promoting environmental justice and sustainability (Dominelli, 2012). Given the limited physical and technical infrastructure available with the state renewable energy development agencies, participation of CBOs/NGOs, PRIs and village level institutions is a prerequisite for ensuring successful

promotion and maintenance of any renewable energy systems in the urban communities as well as the surrounding nearby rural communities. These institutions can also play an important role in providing the interface between the governments and the people, training the communities in the operation and maintenance, and helping in commercialization efforts. The involvement of NGOs/CBOs will also help in replicating similar dissemination approach in other parts of the region. Environmental Social workers can be helpful in the same. This would also expand the professional realm of social work. The National Solar Mission and other policies related to solar energy, need to be worked upon to have better reach and dissemination including role of banks as intermediary between consumers and vendors, market policies, support programs to promote SHS, etc. The study of the sociological understanding of the new technology is a very important perspective for its adoption by a society. Social Scientists can do more interdisciplinary research with Sociologists, Energy Engineers and can bring about a great revolution in the scope of solar energy, its potential impact and thereby achieving SDGs by 2020.

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