Journal of
Poverty, Investment and Development
(JPID)

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Journal of Poverty, Investment and Development
ISSN 2520-4637 X (Online)
Vol.4, Issue 1, pp 1 - 20, 2019

IPRJB
INTERNATIONAL PEER REVIEWED JOURNAL AND BOOK PUBLISHING
www.iprjb.org

SOCIAL DETERMINANTS AND UPTAKE OF SOLAR COOKING PROJECTS- KAKUMA REFUGEE CAMP IN KENYA

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Abstract

Purpose: To investigate the influence of social determinants on uptake of solar cooking projects in Kakuma Refugee Camp in Kenya.

Methodology: A cross-sectional study of 122 systematically sampled households in Kakuma Refugee Camp was done. Questionnaires were completed to collect information about social norms, family size, security and safety, education level and beneficiary participation. Descriptive statistics were used to summarize the findings.

Findings: All the 122 questionnaires completed by respondents had a mean age (SD) 37.8 (8.6); 85% female. Households in Kakuma mainly acquire their domestic fuel via different means within the camp such as firewood collection, purchases from local vendors or donations from aid agencies. Firewood on open fires was the modal cooking practice at 83.6%, followed by charcoal at 15.6% and solar cooking at 0.8%, while use of alternative fuels like gas, ethanol or kerosene was found to be insignificant. Adoption of solar cooking was observed to be under influence of social norms, family size and education. A greater uptake of solar cooking was noted among respondents with higher education levels and lower uptake among large families.

Unique Contribution to Theory, Practice and Policy: Firewood is given to refugees for domestic fuel in Kakuma Refugee Camp; however, getting adequate supplies for the sprawling camp population is getting increasingly difficult, and environmentally damaging. Solar cooking projects have been implemented as possible solutions albeit with little success. There is a need for humanitarian agencies to make refugees aware and conversant with use of the free, sustainable solar fuel to cook and cognizant of benefits of shifting from wood-based cooking to the cleaner solar cooking option. Household cooking is such a socio-culturally embedded practice in Kakuma that context-specific solar cookers that can fry, boil, and bake using ordinally cooking styles of refugees would be key to a wider-spread solar cooking uptake. In addition, there is a gap between the refugees' preferred fuel option and their ability to pay. To get solar cooking to scale, more investment is needed and agencies should explore working with local businesses to subsidize cost of solar cookers in camps. Finally, the Kenya and the ISO standards for clean cookstoves need developing since there is a gap and the existing standards mainly focus on solid fuel, biomass or ethanol cookstoves.

Keywords: *Cook stove, Humanitarian, Green Fuel, Refugees, Solar Cooking*

1.0 INTRODUCTION

1.1 Background of the Study

Access to sustainable fuels such as solar is still very low in Kenya despite the country's huge potential in renewable energy. Wood fuel accounts for over 70% of domestic fuel needs (Kenya's National Climate Change Action Plan 2013). In Kakuma Refugee Camp in Kenya's remote North-West, firewood is part of the emergency supplies given to refugees for domestic fuel needs. However, getting adequate supplies for the sprawling camp is proving to be an up-hill task for the humanitarian agencies. Fuel scarcity in Kakuma drives refugees into clearing of available vegetation, burning plastics or selling part of their food rations for firewood. A report by Kenya Forestry Research Institute (KEFRI, 2008) notes that formation of Kakuma Refugee Camp led to depletion of trees and vegetation cover in the region, which caused rapid devastation of environment. In addition, occasional tensions between refugees and the Turkana host community have been highlighted previously due to chronic competition for a limited biomass resources. Women and girls risk their lives venturing into bushes for firewood collection and are at times victims to sexual assaults, snake bites and scorpion stings, as well as arrests and abductions while foraging in bushes for fuel. In addition, The World Health Organization (WHO) notes that household air pollution due to partial combustion of firewood and poorly ventilated homes as a major threat to health causing over four and a half million premature deaths annually. Use of firewood has been a contentious matter not only in Kakuma but also in other refugee camp setups thus effective strategy for reducing its use needs to be devised. Solar cooking holds great promise.

The Economic Consulting Associates (2014) spotlights Kakuma as having one of the best solar radiation profiles in Africa. This means it can pass for one of the best areas for success in harnessing solar thermal energy. Solar energy is considered an ideal green fuel and a widespread uptake of solar cooking could not only lead to substantial monetary savings and improvement in living standards for refugees, but also make excellent contributions to addressing negative environmental and economic impacts from refugee influx in Kenya. Since 1995 solar cooking projects have been tried in Kakuma and other refugee camps around the world but to date its uptake has been disappointingly low and not as remarkable as initially expected. Contextual social issues such as family size, security and safety, social norms, beneficiary's education level, and their participation can impact on uptake of a particular cooking technology. This study aims to shed light on key social issues behind the suppressed solar cooking uptake in refugee camps in Kenya, a case of Kakuma Refugee Camp.

1.2 Study Area

This study was carried out in Kakuma Refugee Camp in North-Western Kenya, which lies about 800km north of Nairobi, the Kenyan capital. Kakuma is one of the largest refugee camps in the world and has hosted refugees since 1992. The UN's refugee arm, UNHCR, is the lead humanitarian agency in Kakuma, coordinating refugee humanitarian services through support by the Kenya Government and in partnership with other UN, local and international agencies. Since the establishment, the camp has seen a continuous influx of refugees. Currently, the population stands at around 200,000, majority of which are from South Sudan, Somalia, Democratic Republic of Congo and Burundi.

1.3 Statement of the Problem

Refugee households generally cook food through burning firewood over traditional open fires- commonly called "the three-stone method". This cooking practice leads to adverse

environmental impacts due to consumption of trees, and produces smoke and indoor air pollution which cause a range of health problems including lung and eye ailments, as well as birth defects. Adequate firewood supplies for refugee camps in Kenya is proving to be untenable. At Kakuma Refugee Camp for instance, one of the two huge refugee camps in Kenya, refugees are getting about a third of their total fuel needs. The camp is facing fuel scarcity as most of the neighbouring forests are dwindling. Household surveys carried out in both Dadaab and Kakuma refugee camps found that the average energy consumption dropped from 1.5kg of firewood per person per day in 1998 to 1kg in 2010, indicating an increasing scarcity of the supply (Gunning 2014). A report by FAO (2015) highlighted that in 2015 each refugee in Kakuma received only 10kg of firewood for two months against the recommended 15kgs per month- a very acute undersupply.

As an alternative to firewood, solar cooking technology was being introduced in Kakuma several years ago as the inexhaustible green and sustainable fuel solution for the future. Its adoption by the intended beneficiaries has however been paltry despite the current fuel crunch, and camp residents continue to face negative impact on their lives, environment and socio-economy. To alleviate the scarcity the refugees resort to cutting trees or trade-off a portion of their food allocations for charcoal. Others burn plastics, which can have devastating health consequences. The FAO report notes that 6 bowls of maize {6kg} was sold for a basin {10kg} of charcoal in 2015 and that this had a major effect on nutritional standards of the refugees.

Providing safe access to clean cooking fuel is a crucial factor in achieving the UN's Sustainable Development Goals (SDGs) set forth in the 2030 Agenda, in particular SDG 2: to end hunger, achieve food security and improved nutrition. Fronted as a safer, greener and cheaper fuel, solar cooking projects were introduced in Kakuma in the mid 90s. The concept of using free and plentiful sunshine in Kakuma to cook made logical sense and was seen as the antidote to environmental degradation. It was expected to have widespread adoption and bring about substantial monetary savings plus improved living standards for refugees. Nevertheless, a recent report by Moving Energy Initiative (MEI, 2017) highlights solar cooking as one of the least used fuel options in Kakuma. According to UNHCR (2002), refugee camps in other countries like Pakistan and Ethiopia where solar fuel was introduced have also faced low uptake of solar cooking. The common thread throughout refugees' reservations to solar cooking revolve around socio-cultural aspects, but there is limited knowledge on exact issues to be addressed to spur acceptance of solar cooking projects. This study investigates possible explanations with a focus on social determinants such as social norms, family size, security, education and beneficiary participation.

1.4 Objectives

The objective of this study was to investigate the influence of social determinants on the uptake of solar cooking projects in refugee camps in Kenya, a case of Kakuma Refugee Camp. The specific objectives were;

- To establish the relationship between social norms and uptake of solar cooking projects in Kakuma Refugee Camp.
- To determine the relationship between family size and uptake of solar cooking projects in Kakuma Refugee Camp.
- To investigate the relationship between education level and uptake of solar cooking projects in Kakuma Refugee Camp.

- To investigate the relationship between security and uptake of solar cooking projects in Kakuma Refugee Camp.
- To establish the relationship between beneficiary participation and uptake of solar cooking projects in Kakuma Refugee Camp.

2.0 LITERATURE REVIEW

2.1 Theoretical Review

The Theory of Reasoned Action (TRA), advanced by Ajzen & Fishbien [1] postulates that an individual's behaviours and behavioural intentions are as a result of subjective norms and perceived behavioural control. The theory looks into an individual's basic motivation to do something or act in a certain way and suggests that factors that determine his/her intention to perform that action are attitudes and subjective norms. An attitude is considered to be a person's opinion of whether a behaviour is positive or negative, and a subjective norm is the perceived social pressure arising from one's perception. An intention to perform a certain behaviour precedes the actual behaviour (Ajzen and Fishbien 1986). The theory explains that attitudes have two components- evaluation and strength of a belief, and the subjective norms have two components- normative beliefs (expectations of others on an individual) and motivation to comply (how important it is to the person to do what he/she thinks others expect). The theory was mainly used to focus on beneficiaries' intention to engage in a certain behaviour or habit. TRA was extended here in understanding motivational influences behind the adoption of solar cooking technology in a socio-culturally embedded practice like food preparation. The following chart gives the TRA illustration;

<table>
<tr><td>Belief toward an outcome</td><td rowspan="2">Attitude</td><td rowspan="5">Intention</td><td rowspan="5">Behavior/ Action</td></tr>
<tr><td>Evaluation of the outcome</td></tr>
<tr><td>Beliefs of what others think</td><td rowspan="3">Subjective norm</td></tr>
<tr><td>What experts think</td></tr>
<tr><td>Motivation to comply with others</td></tr>
</table>

Figure 1. **TRA Flow Model**.

Source: Ajzen & Fishbien (1986)

The Technology Acceptance Model (TAM), which is an extension of the Theory of Reasoned Action (TRA) is the most widely applied model for understanding users' acceptance and usage of technology (Vankatesh, Morris, Davis & Davis, 2003). This model postulates that when users are presented with a new technology, a number of factors influence their decision about how and when they will use it. These factors include Perceived Usefulness (PU) - the degree to which a person believes that using a particular technology would enhance his or her efficiency, and the Perceived Ease-Of-Use (PEOU) – the degree to which a person believes that using a particular system would be free from effort (Davis, 1986). Figure 2 gives the TAM flow chart;

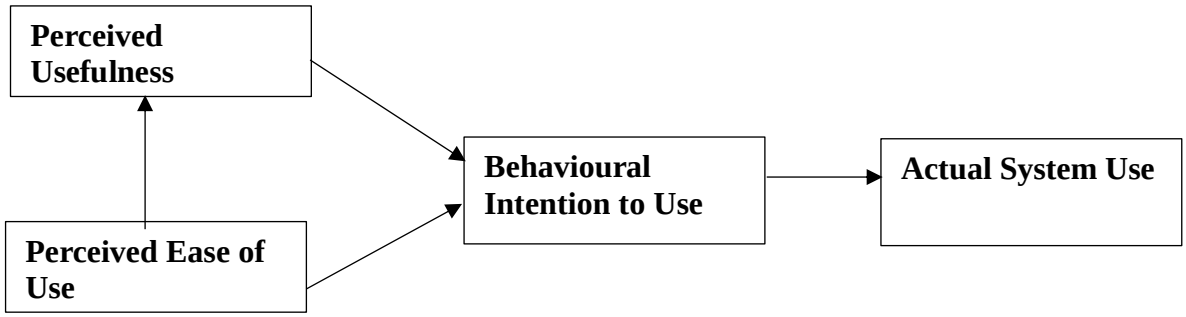

Figure 2: **TAM Flow Chart.**

Source: Vankatesh, Morris, Davis & Davis, 2003

TAM assumes that when someone forms an intention to act, they will be free to act without limitation; however in the real world there will be many constraints, such as limited freedom to act (Davis, Bagozzi & Warshaw, 1989), and according to Viswanath and Davis (2000), both social influence processes (subjective norm, voluntariness, and image) and cognitive instrumental processes (job relevance, output quality, result demonstrability, and perceived ease of use) significantly influence user acceptance of a new technology.

2.2 Empirical Review

Social determinants are aspects that affect people's way of life and consist of conditions that people live in. According to American Association for the Advancement of Science (AAAS) [2], social aspects makes it difficult to assign blame or credit to any one person in a society for acting in a certain way because like species, societies evolve in directions that they are opened to or constrained in. AAAS further adds that a group situation may provide the rewards of companionship and acceptance to individuals for going along with the shared action of the group. Social customs provide guidelines for conduct and raise a standard to be upheld in the communities. According to Beck and Martinot (2010), some socio-cultural barriers that exist in a community can prevent uptake of a renewable energy project. The attitudes the community residents have toward a development and the specific actions being proposed as well as their perceptions from the community, and their personal well-being are important factors of the social effects of a proposed action. Puzzolo et al (2013) mentions that aesthetic appeal and subsequent social status improvement associated with a new technology is usually a motivating factor for both its adoption and sustained use. In Kakuma varying attitudes, concerns and apprehensions among refugee families regarding suitability of solar cookers to prepare food for a family were noted. Social norms, security, education level, family size and beneficiaries' involvement were considered to have a great deal of issue on uptake of solar cooking technologies.

Focusing on social norms, the researcher was cognizant of the fact that traditions may dictate decisions on where cooking takes place; whether in a hut in the evening or in a kitchen shelter during the day or out in the open when the sun is out and hot. Since ordinarily solar cooking must be done in the open under direct sunshine, the decision on place and time of cooking has had a direct impact on success of solar cooking projects in the camp. Previous reports cited reluctance in changing cooking times and practices by refugees in different countries as a factor in success of solar cooking. The researcher recalled that sex-role grouping may confine human potential for an activity, and attitudes of both men and women as users of the technology; this would be a critical element in influencing uptake of solar cooking. The researcher also recalled that in previous projects, beneficiaries raised concerns

of whether solar cooking was suitable in preparing their traditional dishes and local cuisines for large families, while retaining their normal taste, safety and colour. From a study on influence of social economic factors on environmental conservation projects by Lemons (2003), family size was found to have a significant influence on success of the green energy projects. According to Solar Cookers International, SCI (2004), individual household knowledge and perceptions regarding solar cooking is likely to be of great influence in its adoption and future decisions as to whether or not to use solar cooking kits. SCI adds that perceptions were likely influenced by both positive and negative experiences of families, neighbours or relatives who had adopted the cooking method.

Security was another factor where the researcher was aware that certain safety and security risks inherent in a particular cookstove design have been seen to impact its adoption in a community. Refugee worries on safety of using solar cookers such as eye glare and theft, or conversely for other traditional cooking options the fact that firewood collection in bushes exposed women to sexual assaults, banditry or risk of arrests by local authorities was a major aspect focused on. Anecdotal reports indicated that refugees were reluctant to place their limited food rations out in the open to solar cook for fears of theft and robbery, hampering the technology adoption. On the other hand, solar cooking technology was lauded as the least unhealthy to both the user and the environment. The interplay of these factors was considered.

Focusing on education, the researcher considered the views of Kumar (2003) that there is an improvement in awareness of energy efficient technologies with increasing education, and Howe's (2009) assertion that education has an effect on projects success, both at the individual level- by having a positive influence on behavioral intention, and at the project level on overall project success. Similarly, Zarnikau (2003) demonstrated a positive correlation between education and willingness-to-pay for utility investments in energy efficiency, concurring with Dias et al (2004) study that education is one of the most powerful tools in raising the awareness on the need for rational energy use.

The researcher considered Khwaja's (2008) report that beneficiary participation can be used as a catalyst to generate not only ideas for renaissance of projects and their implementation, but also ideas to further improve existing project features among communities. The UNHCR (2004) mention that if refugees built their solar cookstoves themselves it would take away some of the suspicion towards solar cooking equipment and put them more at ease using it in daily life. According to FAO (2003), some of the key benefits of beneficiary participation on development projects are enhanced coverage and increased effectiveness and efficiency. Puzzolo (2013) noted that involving the community throughout the process from the identification of an appropriate designs to distribution created a greater sense of ownership in the cookstove promotion projects, and fostered women's engagement especially for stove uptake in low- and middle-income countries.

3.0 METHODOLOGY

A descriptive research design was used because it enabled the researcher to investigate, record and then describes in a scientific manner attributes that influence uptake of solar cooking projects in refugee camps. This study was undertaken in Kakuma Refugee Camp in Kenya between 21st and 26th November 2016 involving 122 respondents from around 2,000 households- the past beneficiaries of solar cooking projects. The minimum sample size needed was 100, derived from Nassiuma (2000) formula for sample size $n = \frac{NC^2}{C^2+(N-1)e^2}$ where

N = the population, C = the coefficient of variation (considered as 0.5), and e = the precision level (0.05). Demographic attributes considered were age, marital status and gender of the respondents.

Systematic sampling was employed with every 20th beneficiary chosen; the first element being selected at random to avoid any bias and subsequent elements at a sampling interval S= 20, obtained by dividing the population size N by sample size n; S = $\frac{N}{n}$ = $\frac{2000}{100}$ = 20. The researcher was cognizant of the fact that over the years significant population and demographic changes have taken place in the refugee camp. Kenya Government's (2013) report indicate that resettlements, repatriations and voluntary returnees of Somalis, Sudanese, Ethiopians, Ugandans and Rwandese were reasons behind large demographic changes in Kakuma Refugee Camp. In addition, the past solar cooking implementing agencies had halted their operations in the camp and departed the country and it was not possible to reach them for interviewing and thus no available listing of past beneficiaries for an ideal sampling frame was available. The researcher therefore aware of these challenges set out to physically trace former solar cooking beneficiaries to their individual houses within the expansive camp. Ochola & Ngige (2015) notes that a sampling frame could somewhat deviate from the theoretical target population.

Self-administered questionnaires based on standardized, predetermined set of questions developed from constructs identified in the literature review were used to collect and record information. A survey-based approach using clearly stated investigative questions on independent variables- the social determinants, with an aim of establishing their influence on the dependent variable- the uptake of solar cooking was used. Validity of the questionnaire was assessed by checking if they matched the content of the matter under investigation. A pilot test with 13 subjects was run to assess clarity and detect any weakness or error on the questionnaire. Cronbach's alpha value obtained was 0.706, indicating a satisfactory questionnaire in terms of reliability and internal consistency. Appropriate descriptive statistical forms were then used to summarize and present the data features, and the multiple linear regression model employed in predicting variations in dependent variable due to independent variables.

This study was reviewed by Kenya's National Commission for Science, Technology and Innovation (NACOSTI)- a state institution responsible for regulating and assuring quality research in science, technology and innovation sector; a research permit was obtained vide permit no. NACOSTI/P/16/39802/14243. Advance official letter from Kenyatta University graduate school was also obtained to assist in getting consent from the camp authorities in assessing and undertaking studies in the refugee camp. Respondent protection was further enhanced by obtaining advance interview consent, and by requesting them to not indicate their names on the questionnaire. The data were analysed anonymously and reported.

4.0 RESULTS AND DISCUSSION

4.1 Sample Characteristics

Data collection was undertaken for five days from 21st to 26th November 2016 in Kakuma Refugee Camp where a total of 122 questionnaires were issued, filled and collected at the end of 5 days for analysis.

4.2 Demographic Characteristics

Over 98% of the respondents were below 50 years and the majority were within age bracket 36-50 years (mean age (standard deviation (SD)) 37.8yrs (8.6), with more than two-thirds of them married. 85% of the respondents were women, who carried out over 95% of all domestic cooking in the camp. This finding is consistent with Casserly (2010) report that highlight domestic cooking being generally considered a woman's role in most societies.

4.3 Uptake of Solar Cooking Projects

The commonest fuel used for cooking was firewood which was typically burned on open fires (83.6%), followed by charcoal (15.6%) with very limited use of solar (0.8%). This was consistent with earlier studies by Moving Energy Initiative- MEI (2017) that firewood is the main source of cooking fuel and that solar, LPGs and ethanol fuels constitute less than 1% of household fuel in Kakuma Refugee Camp. In contrast to fuel used, charcoal was the most preferred fuel type (37.7%), followed closely by solar cooking (33.6%) and firewood (24.6%). Only 5% indicated a preference for gas or kerosene. Charcoal was considered the most convenient fuel for its flexibility to cook at any time of the day or night, and for the simplicity in use at no extra-training (Figure 1).

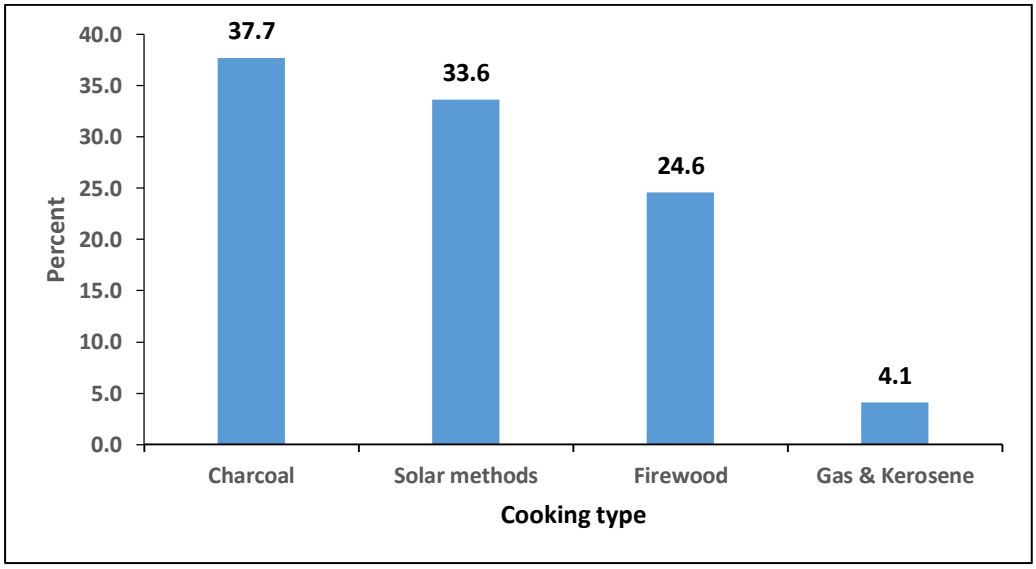

Figure 1. **Cooking Fuel Preference among Refugees in Kakuma Camp.**

Source: Survey data (2016)

Hygiene, health and environmental aspects were cited as main reasons for solar cooking preference, with respondents mentioning its lack of smoke, emissions and soot generation, as well as its time-saving advantages and safety aspects compared with firewood which would usually blacken pots during cooking, and require trips into risky bushes to fetch. The MEI (2017) mentions that cooking with biomass fuel in Kakuma is laden with problems such as severe indoor air pollution that causes respiratory illnesses and that users face risks such as

burning themselves and house fires. Firewood supplies in Kakuma is hugely governed by the availability of humanitarian resources to UNHCR, and given the current refugee funding situation for UN on humanitarian operations, refugee fuel supply has been constrained resulting in reports of refugees receiving less fuel quantities than recommended. This situation is said to escalate protection challenges as refugees, in the absence of other fuel alternatives, resort to tree felling or firewood gathering from neighbouring bushes, exposing themselves to banditry, arrests or Sexual and Gender-Based Violence (SGBV).

4.4 Social Norms and Uptake of Solar Cooking Projects

It was necessary to gauge influence of social norms on uptake of solar cooking projects in Kakuma Refugee Camp and the variables that were theorized to partly or fully explain social norms were gender of the primary cook at home, their marital status, the preferred place and time of cooking at the household and its most common cuisine.

4.4.1 Gender of the Primary Cook at Home

Over 95% of domestic cooking roles in the camp were done by women. This was consistent with ENERGIA (2014) that women are primarily responsible for cooking in virtually all cultures. In relation to solar cooking, a bigger portion of the men who cook were seen to prefer solar cooking compared to their female counterparts. Solar cooking has close similarities with grilling- an outdoor cooking activity that is considered to be a man's role Casserly (2010).

4.4.2 Marital Status of the Primary Cook at Home

It was important to investigate the influence of marital status on uptake of solar cooking projects. According to Mancino & Newman (2007), family dynamics do have an influence on decision regarding time and method of cooking whereby married women are seen to spend more time preparing food in their homes than their unmarried counterparts. The amount of cooking time at the cook's disposal has a bearing on choice of cooking method. The study showed that more than two-thirds of the respondents were married whereas the single, windowed and separated/divorced persons constituted less than a third (27.0%) as presented in Table 1;

Table 1

Marital Status of the Respondents

Marital Status	Frequency	Percent
Married	88	72.1
Single	19	15.6
Widowed	12	9.8
Separated/divorced	3	2.5
Total	122	100.0

Source: Survey data (2016)

4.4.3 Preferred Place of Cooking

The preferred place of cooking was investigated too as most domestic solar cookers must be exposed to direct sunlight to function and cooking indoors would have an adverse effect on

efficiency of solar cooking. The data showed majority of the respondents (62%) preferring to cook indoors, with only 38% cooking outdoors.

There was also a general preference in preparing food in Kakuma under an enclosed area with safety and privacy concerns cited. Strong winds that bombard Kakuma could also be a major hindering factor in cooking outdoors. Solar cooking is said to be affected under windy conditions whereby in a previous study some solar cookers were seen to be blown away, or cool off rapidly and dramatically affect cooking time, which in many cases prevented achievement of sufficient temperatures for baking or frying Dancing (2012).

4.4.4 Preferred Time of Cooking

Solar thermal power cannot be stored easily and therefore cooking should be planned around 10am to 3pm as much as possible- times of highest sunshine intensity within the tropics. According to Cantina West (2008) the ideal cooking window (prime hours) within the tropics are to be found between 11:00 am to 3:00 pm because the UV rays through the earth's atmosphere are usually at their peak due to the position of the sun being more or less overhead. However slow cooking items such as stews, chili, pepper foods and soups can cook and boil at lower temperatures and can be cooked throughout the window of sunshine. Therefore, the preferred time of cooking was investigated; data showed that approximately three out of every four respondents cook in the daytime as presented in figure 2.

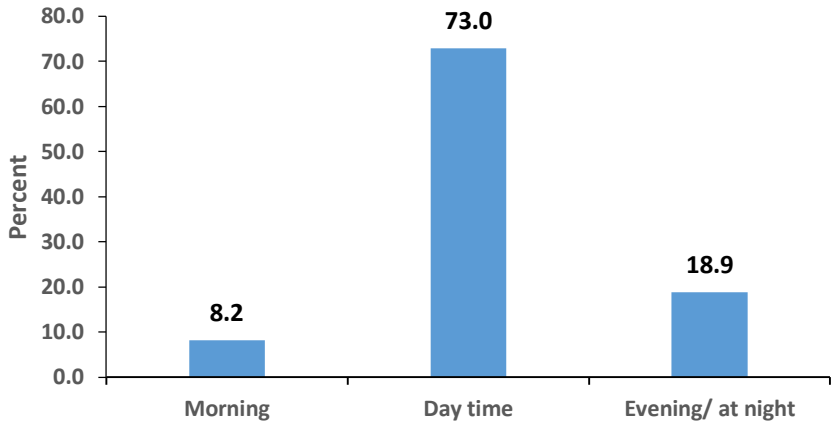

Figure 2. **Preferred Time of Cooking in Kakuma.**

Source: Survey data (2016)

4.4.5 The Household's Common Cuisine

The household's common cuisine was investigated to gauge compatibility of the users' recipe with solar cooking (Table 2).

Table 2: ***Common Cuisine in Kakuma Refugee Camp***

Food type	Frequency	Percent
Ugali/ posho Porridge- (cornmeal)	41	35.3
Githeri	29	25.1
Pepper foods	16	13.8
Rice	12	10.3
Injera, Kisira/ kisira (pastries)	6	7.0
Bread/chapatis/wheat or baked products	5	4.2
Others	5	4.3
Total	116	100.0

Source: Survey data (2016)

Ugali or posho - a stiff porridge made by mixing maize meal with boiling water was found to be the most common cuisine in Kakuma at 35.3%. Githeri- a boiled mixture of dry corn and beans, was the second most common food at 25.1%, followed by pepper foods and rice at 13.8% and 10.3% respectively. Wheat products like bread and pastries including some other maize products like injera- a giant Ethiopian spiced pancake made from maize or wheat flour, were among the least consumed foodstuff in the camp, perhaps due to high cost of wheat flour compared to other commodities in Kakuma. Nevertheless, the study established that 44% of the respondents had encountered difficulties cooking pastries- injera or chapatti whereas 56% said that they were fine with use of solar fuel for all their domestic cooking.

4.5 Security and Uptake of Solar Cooking Projects

Interaction between security and uptake of solar cooking projects was investigated. Security variables that the researcher believed could produce differences in solar cooking adoption in the camp were theft cases attributed to solar cookers and attacks faced by beneficiaries for use of firewood. Health and safety-related problems due to firewood use were also considered. A third of the respondents had faced insecurity in one way or the other. Theft of solar cookers was also reported whereby food had disappeared as it cooked outdoors. There were other incidences like armed robbery with thieves having broken into homesteads making away with solar cooking kits. About 11.5% of respondents highlighted concerns of eye glare- a blinding effect or irritation to their eyes due to intense sunlight while adjusting the cookers to the sun's direction. A report by Howard Boldt of SCI (2001) highlight that exposing eyes to a light of intensity greater than normal sunlight may result in serious and permanent impairment. Solar cookers can benefit greatly by having passive sun trackers for automatically adjusting solar cookers to the sun direction. To limit sun glare, provision of solar cookers with passive solar trackers, a canopy or sun-shading could be a plus as well as providing sunglasses alongside the cookers. For institutions and mass-cooking scenarios like in schools, restaurants and other organization cafeterias, curved reflectors directing sun beam onto the cooking place inside the kitchen would be commendable.

On the other hand, firewood use revealed a couple of downsides in relation to health and safety. Over 70.5% of respondents had faced eye irritations and respiratory problems from smoking fires and 56.6% of their family members encountering attacks, arrests and sexual violence while in bushes collecting firewood. The UNHCR (2008) report highlighted that Kakuma refugee women and girls experienced significant risks of sexual and gender-based violence (SGBV) while foraging into dangerous bushes in search of fuelwood. Mwangi

(2012) concurs that sexual violence had taken a non-discriminate forms in Kakuma Camp, targeting both women and men from multiple nationalities and cultures.

4.6 Family Size and Uptake of Solar Cooking Projects

The influence of family size on solar cooking uptake was investigated. Data revealed varying sizes of households in the camp ranging from 1 to 15 persons. These households were categorised into four sets 1-3, 4-7, 8-10 and 11 plus members. Families with 4 to 7 members was identified as the modal-set at 59% with a mean of 6.3 and a standard deviation of 2.6. Family sizes 8-10, 1-3 and 11-15 constituted 23%, 12.3% and 5.7% respectively as presented in figure 3. The average number of children and adults was 3.9 and 2.8 per household respectively. Almost 30% of homesteads had over 7 persons.

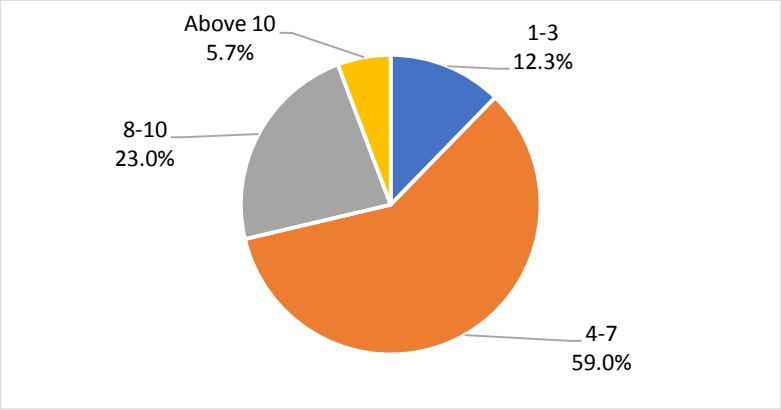

Figure 3. **Respondents Household Sizes.**

Source: Survey data (2016)

A cross tabulation revealed a tendency for large families to use firewood to cook instead of other alternatives as shown in Table 3. The smallest family size bracket 1-3 had the highest preference for solar cooking compared to other fuel options. This trend portrays smaller families as more likely to adopt solar cookstoves compared to the large ones.

Table 3

Cross-Tabulation of Family Size with the Families' Choice of Cooking Fuel

Fuel Type	Family Size			
	1-3	4-7	8-10	>10
Firewood	20.0%	26.4%	21.4%	28.6%
Charcoal	26.7%	40.3%	32.1%	57.1%
Kerosene	0.0%	0.0%	3.6%	0.0%
Gas	0.0%	1.4%	10.7%	0.0%
Solar methods	53.3%	31.9%	32.1%	14.3%
Total	100.0%	100.0%	100.0%	100.0%

Source: Survey data (2016)

Consistent with this finding, a study on green energy projects in Magadi-Kenya by Lemons et al (2003) noted large families as having less likelihood of adopting green energy projects compared to smaller families, indicating that probably the trend could be due to the number of adults working in the household, as well as the higher number of women and children

available for firewood gathering; which could be translated to mean a lower opportunity cost on firewood collection for large families compared to small families.

4.7 Education Level and Uptake of Solar Cooking Projects

Relationship between education levels of beneficiaries and solar cooking uptake in Kakuma was also investigated and the data showed that over a third of the respondents had never attended schooling. Around 40% had only gone up to primary level, 20% to secondary level and only 4.3% had post-secondary education (Figure 4).

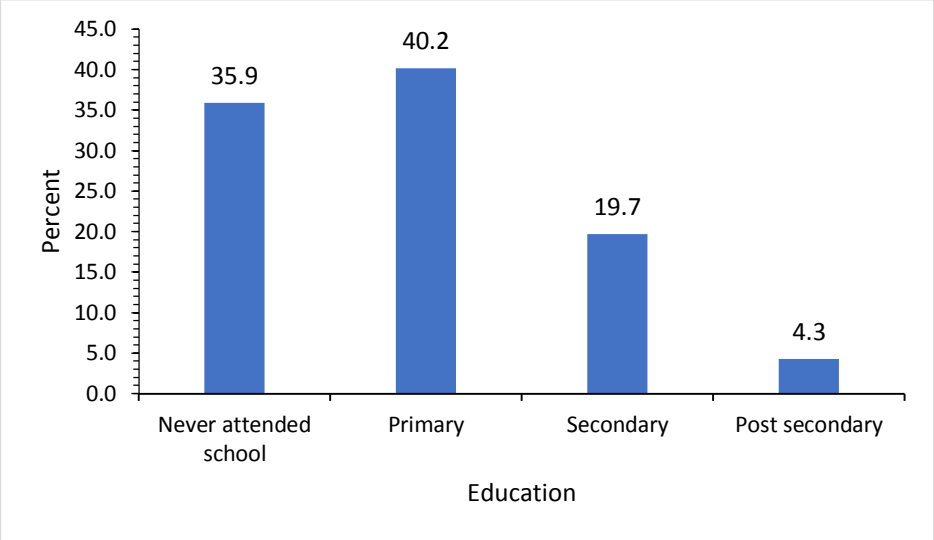

***Figure 4*. Education Levels among the Respondents.**

Source: Survey data (2016)

Cross-tabulation showed that solar cooking was more popular among respondents with upper levels of education as reflected in Table 4.

Table 4: *Cross-Tabulation of Education Level with Choice of Cooking Fuel*

Fuel Type	Education Level			
	Never attended school	Primary education level	Secondary education level	Post-secondary education
Firewood	19.0%	38.3%	8.7%	0.0%
Charcoal	50.0%	27.7%	21.7%	80.0%
Kerosene	0.0%	2.1%	0.0%	0.0%
Gas	4.8%	2.1%	4.3%	0.0%
Solar methods	26.2%	29.8%	65.2%	20.0%
Total	100.0%	100.0%	100.0%	100.0%

Source: Survey data (2016)

Firewood was found to be the least popular among respondents with schooling beyond primary level. Education is seen as a useful tool for environmental conservation and sustainable development. In green energy use, education is considered as one of the most powerful tools in raising the awareness of the need for rational energy use (Dias, Mattos and

Balestieri 2004). According to Kumar et al (2003), there is an improvement in awareness of energy efficient technologies and adoption with increasing education. Howe (2009) also asserts that education has an effect both at the individual level, by having a positive influence on behavioural intention, and at the community level on overall project success in developing countries. Other studies have demonstrated a positive correlation between education and willingness-to-pay for utility investments in energy efficiency as well Zarnikau (2003).

4.8 Beneficiary Participation and Uptake of Solar Cooking Projects

Similarly, relationship between beneficiaries' participation and the uptake of solar cooking projects was investigated. The previous solar cooking projects had been rolled-out by various agencies in the camp. Investigation established that 99% of the solar cookers were not in proper working condition; 84% of the cookers broke down, 11% were stolen and 5% swept away by floods or blown away by strong winds- implying that weather conditions are a factor in solar cooking uptake. Over 99% of the respondents stated that they discarded their solar cookstoves after break-down, citing lack of repairs and maintenance skills. About 3 out of every 4 beneficiaries highlighted a lack of user-training as well as non-involvement in projects design and inception. Beneficiaries that had participated in solar cooking said that they had taken part in camp demonstration on cooking different local recipes. Positive views on solar cooking were more noticeable among this group compared to their counterparts who had no form of involvement. Some technical downsides noted included limited skills and awareness on operation and maintenance (O&M), inhibitive social-cultural cooking habits that could be overcome with user advocacy and sensitization, and low education level and skills among the beneficiaries. Studies on projects funded by multilateral donor agencies in developing countries consistently show that beneficiary participation is more significant than any other factor for achieving success of projects. Many people believe that beneficiary participation in decision-making contributes greatly to the success of projects, because when people influence or control the decisions that affect them, they have a greater stake in the outcome and will work harder to ensure success (World Bank 1995). According to Karuti (2015), involvement of beneficiaries in project activities achieve more effectiveness in attaining intended objectives.

4.9 Regression Analysis

Social determinants influence the uptake of solar cooking projects in Kakuma Refugee Camp by 12.8% as show in Table 5 of the multiple regression model. However there are other factors not accounted for in this study that impact solar cooking uptake in the camp by 87.2%. Refugees generally do not have work permits in their hosting countries thus cannot engage in gainful employment. This affects their purchasing power and choice. They must rely on aid supplies from humanitarian agencies for essential commodities and services like shelter, food, fuel and clothing. Solar cooking in Kakuma was previously funded by various donors and humanitarian agencies. Stoppage of active roll-out and its implementation some years back therefore meant that refugees had no choice for alternative fuels but to settle for the UNHCR-funded free firewood in camps.

Table 5: ***Multiple Regression Model***

Model Variable	Unstandardized Coefficients	Std. Error	Standardized Coefficients	t	Sig.
	B		Beta		
(Constant)	0.149	0.226		0.660	0.511
Social norms (X_1)	0.089	0.050	0.160	1.793	0.076**
Security (X_2)	0.032	0.053	0.055	0.598	0.551
Family size (X_3)	-0.029	0.016	-0.153	-1.745	0.084**
Education level (X_4)	0.326	0.098	0.290	3.321	0.001***
Beneficiary Participation	-0.151	0.099	-0.145	-1.520	0.131

Model Summary

Model R	R Square	Adjusted R Square	Std. Error of the Estimate
ANOVA			
0.406	0.164	0.128	0.443

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	4.477	5	.895	4.567	.001
Residual	22.744	116	.196		
Total	27.221	121			

Predictors (constant), Social norms, Security, Family Size, Education Level, Beneficiary Participation

Dependent Variable, Uptake of Solar Cooking Projects

Source: Survey data (2016)

The analysis of variance (ANOVA) shown in Table 5 yielded a p-value of 0.01, meaning that the overall model was statistically significant. The linear regression results show that social norms, security and education level positively influence uptake of solar cooking projects while family size and beneficiary participation have had a negative influence on uptake of solar cooking projects.

4.9.1 Correlation between Social Norms and Uptake of Solar Cooking Projects

From the above relationship, we deduce that a unit increase in social norms leads to an increase in uptake of solar fuel projects by 0.089. With a p-value = 0.076, the influence of social norms was significant at 10% significant level. This positive relationship is consistent with Berkowitz (2004) findings where social norms were seen to shape individuals' behaviour, actions and perception towards community projects. The social norm included attributes such as gender, marital status, time and place of cooking. A higher men's participation in domestic cooking as well as adjustment of place and time of cooking from indoors to outdoors during daytimes would translate to an increase in uptake of solar cooking technology in Kakuma Refugee Camp.

4.9.2 Correlation between Family Size and Uptake of Solar Cooking Projects

Family size showed a coefficient of -0.029 indicating that with bigger families the uptake of solar cooking projects reduces. A unit increase in family size decreased solar cooking uptake by 0.029. A statistical test p-value of 0.084 showed that the influence of family size was significant at 10% significance level. The finding was consistent with the CIR (2003) report that solar cooking methods were more suited to small families or families with small children in Kakuma, and were viewed as less convenient to large families. Similarly, Puzzolo et al (2013) noted that larger families were less likely to adopt green energy projects, inferring to the bigger number of adults working in a household, as well as the number of women and children available for fuel gathering; a low opportunity cost was attributable to time spent in traditional firewood collection. Similarly the low-cost solar box and panel cookstoves earlier distributed at the refugee camp were convenient for around five persons per household. This posed a limitation on quantities of food that could be cooked at a given time thus pushing large families out of the solar cooking bracket.

4.9.3 Correlation between Education Level and Uptake of Solar Cooking Projects

Education level showed a significant positive regression coefficient of 0.326 meaning that a unit increase in education level produced an increase in adoption of solar cooking projects by 0.326. The more educated the solar cooking beneficiaries are, the greater is the likelihood of them embracing solar cooking technology. This finding is consistent with Howe (2009) conclusion that for renewable energy adoption, education acts as a stimulus on positive behavioural change. Dias et al (2004) also notes that education is one of the most powerful tools in raising the awareness on need for rational energy use, tallying with Zarnikau (2003) finding that there was a positive correlation between education and willingness-to-pay for utility investments in energy efficiency projects. The analysis gave a p-value of 0.001 indicating a strong influence of education on uptake of solar cooking projects.

4.9.4 Correlation between Security, Beneficiary Participation and Uptake of Solar Cooking Projects

Security had a positive regression coefficient of 0.032 meaning that an improvement in security and safety lead to a greater uptake of solar cooking projects. It was however statistically insignificant with p-value = 0.551. A test on beneficiary participation also gave p-value = 0.131, revealing that beneficiary participation is also statistically insignificant at 10% significance level.

5.0 SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusion

The study established that social determinants influence uptake of solar cooking projects within Kakuma Refugee Camp. Education level has a significant positive influence on uptake of solar cooking projects and factors such as social norms and security largely stimulate uptake of solar cooking too. Socio-cultural attributes of social norms like gender, households' common cuisine and the preferred place and time of cooking affect preferences on type of cooking fuel adopted for domestic use. Family size and beneficiary participation negatively influence uptake of solar cooking; the influence of beneficiary participation is however statistically insignificant.

5.2 Recommendation

Social determinants shape individuals' behaviour, actions and perception and were found to be a critical component in the uptake of solar cooking projects. A key approach to boosting solar cooking uptake in refugee camps would to develop context-specific solar cooker designs that address socio-cultural cooking habits of users. A general preference for cooking indoors after dusk mainly by females can be addressed by undertaking a sustained community solar cooking advocacy to disseminate information on how to cooking using sun, appropriate cooking times/windows and positions at home and also to encourage cross-gender participation in domestic cooking. A culturally-embedded activity like domestic food preparation needs a lot of end-user involvement in developing solutions to issues affecting them. Success of many renewable energy interventions depend on beneficiaries taking the initiative and choosing what they want based on information at their disposal, as opposed to what they are offered. For the night-time cooks, provision of thermal storage for solar cookers such as thermal retention kits like hay or fireless baskets should be introduced accompanying solar cookers in refugee camps. Significant research is needed also to develop means of capturing and storing the sun's thermal energy during the day and utilizing it at night.

Refugee participation in implementing fuel solutions can pre-empt suspicion towards solar cooking technology and gives them more freedom using it in their daily life. The UN's refugee arm, humanitarian aid agencies and the government of Kenya should ensure that refugees are involved ahead of any roll-out of any fuel intervention project. Most of the solar cookers earlier distributed in the Kakuma Refugee Camp were mainly the panel type, which normally has a low thermal output and not quite suited for food preparation for large families. Considering the existing local practices and average family sizes, humanitarian aid agencies handling fuel supplies such as LOKADO and UNHCR need to explore introducing higher efficiency cookers like parabolic solar concentrators or lens or box solar cookers to address the energy gap.

Studies show strong positive correlation between education and uptake of renewable fuels. Generally the academic levels in the camp are very low. It is incumbent upon the Kenyan Government and the refugee aid agencies to invest and boost education standards in Kakuma camp. Improvement in education levels would spur greater awareness and adoption of energy efficiency technologies. Advocacy could help build user-knowledge on best solar cooking time/window, precautionary measures that should be observed when using solar cookers, the operation and maintenance (O&M) aspects of solar cookstoves. A dedicated local solar cooking implementing agency should be identified and supported by the stakeholders led by the GoK to spur much-needed local skills transfer, monitoring and evaluation of renewable energy projects and setting-up of cooker assembly centres. Partnerships of a local community-based organization of an NGO could be explored by global solar cooking actors such as the Solar Cookers International (SCI).

Solar cookers at subsidized prices would enable displaced persons afford the cleaner and safer solar cooking fuel and encourage transitioning from the traditional unhealthy biomass use. The private sector involvement in sustainable fuel supply via subsidies, incentives and concessionary supports to increase sale and distribution of non-wood based fuels in and around Kakuma need to be explored by the UN refugee aid agencies, NGOs, global solar cooking community and the host governments.

A limited lifespan of solar cookstoves, durability and performance concerns observed can be avoided through development of comprehensive cookstove testing and performance protocols. The current Kenya Bureau of Standards (KEBS) performance guidelines for clean cookstoves are limited in scope. The biomass and ethanol stove standards are at development stage but standards for solar cookstoves are yet to be developed. Likewise the solar cookstove performance issues are yet to be addressed at the International Organization for Standards (ISO) platform. Incorporating an ISO or Kenya Standard (KS) protocols will provide in-field guidance for performance and evaluation of different solar cooker designs in the market, and underpin a global performance platform needed by manufacturers, green energy enthusiasts, NGOs and innovators in solar cooking sector.

Acknowledgements

Thanks to my wife Dr. Victoria Mawira for her great support, prayers and encouragement throughout the study. Special thanks to Elias Thuranira for help in the questionnaire development and data analysis, Dr. Paul Waithaka of Kenyatta University for guidance at the proposal development stage, Eric Mativo of NRC, Raphael Nyabala of NCCK and Opete of LOKADO for help in research materials and data collection. Thanks also to Elly Wallis for help in preparing the publication manuscript. We also thank the NIHR Global Health Research Unit on Lung Health and TB in Africa at LSTM - “IMPALA” for helping to make this work possible. In relation to IMPALA (grant number 16/136/35) specifically: IMPALA was commissioned by the National Institute of Health Research using Official Development Assistance (ODA) funding. The views expressed in this publication are those of the author(s) and not necessarily those of the NHS, the National Institute for Health Research or the Department of Health.

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