The influence of Subsidy Initiatives on the adoption rates of sustainable energy technologies in Kakuma refugee camps

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Abstract

Energy subsidy is an essential ingredient in diffusion of new technologies .Subsidy initiatives in sustainable energy technology market in humanitarian settings aim to lower the market price and spread the duration of payments hence creating an incentive to consume more of a good or service. Adoption of sustainable energy technologies can thus be discussed in the light of subsidy initiatives structure. Some of the twin reasons for low adoption of SET in the camps is high upfront cost that inhibits access and installment payment that can foster adoption. Therefore, an effective subsidy structure should facilitate access at the inception and adoption in the long term. The purpose of this study was to investigate the influence of subsidy initiative on the adoption rates of sustainable energy technologies in Kakuma refugee camps. The study adopted concurrent descriptive cross sectional and correlation research designs. Both simple random and purposive sampling methods were used to sample respondents. A quantitative tool was administered on 286 refugee respondents, two focus group discussions were held, 29 key informant interviews were conducted while 10 observations were made. Data was analyzed using SPSS by applying both descriptive and inferential statistical procedures. The study findings revealed that the predictor variable identified as subsidy initiative, had a significant positive influence on adoption rates of sustainable technologies. The study concludes that subsidy initiative factors has a role on adoption rates of sustainable energy technologies as indicated by the value $\beta 1 = 0.184$, $t = 3.644$, $p<0.05$ and UNHCR should establish joint framework that leverages on government subsidy, PAYGO initiative, refugee ability to pay, UNHCR budget for energy and ability of the refugee leadership to sensitize the refugee community to foster adoption rates

Keywords: *Adoption rate, subsidy initiative, sustainable energy technologies, Kakuma refugee camps, cooking, lighting.*

Introduction

Subsidies to sustainable energy have been widely used, often with great success, however, there are still challenges with the wide use of incentives for deployment of sustainable energy technologies. First, subsidies to sustainable energy may be opposed by those with an interest in maintaining the existing energy system (Bjoern, 2020). Second, if done incorrectly, introducing sustainable energy subsidies can increase the distortions in energy markets by further altering the difference between the true market price and prices charged. Using these subsidies effectively (and minimizing distortions) requires that the associated costs and impacts are regularly and rigorously assessed (Dees, 2017). The sustainable energy subsidy takes two forms, that is, they can be delivered directly as financial transfers or indirectly by virtue of preferential tax treatment (Hojnik & Ruzzier, 2016). Humanitarian donors fund subsidies to lower the price, and hence increase the purchase and use, of socially beneficial products in the developing world (Simon, 2016). Similarly, donors fund subsidies to increase

the purchase and use of improved cook stoves (ICS) because they are more energy-efficient and less-polluting than traditional cook stoves.
Historically, donor efforts to lower the price of ICS have focused on non-commercial channels, with distribution through non-governmental organizations or government agencies (World Bank, 2017)

Demand Side Subsidies

Demand-side subsidies are typically aimed at increasing the purchasing power of consumers. When demand-side subsidies are targeted at buyers, these typically subsidies either the sustainable energy solutions down payment, or instalments repayment. Upfront subsidies for down payments are typically more useful for households who struggle to make large one-off payments, despite reasonably unreliable income flows. They are also a relatively transparent and easily calculable subsidy (Verplanken, 2006). Interest rate subsidies tend to be more useful for households who are able to make large down payments through savings or access to social networks, but who struggle to afford installment payments over time.
The sustainable energy subsidy distribution pattern needs to be scrutinized to assess whether the policy benefits refugees, a normative argument often made while granting any input subsidy. The quantum of sustainable energy subsidy flow is related to market efficiency as a greater flow of subsidy can take place only if the sustainable energy markets work efficiently. This efficient operation is dependent, to a large extent, upon the supply of quality sustainable energy solutions (Verplanken, 2006).

Aside from these more conventional subsidies, policymakers can also subsidize innovative sustainable energy solutions where refugees use a portion of their fuel payments to contribute to the purchase price of the SE solution they are currently owning. These schemes provide a more flexible purchasing option for households who struggle to save whilst at the same time paying for fuel (Barbieri, Riva, & Colombo, 2017). Demand-side subsidies are usually more efficient than supply-side ones as they do not create distortions in the market where sustainable energy solutions are provided. They have been increasingly popular in more developed economies with better-functioning sustainable energy markets and higher-incomes; subsidies can therefore be targeted towards particular low-income households where purchasing power is their main barrier to sustainable energy accessibility (Wang, 2011)

Supply Side Subsidies

Renewable energy subsidy support mechanisms are necessary instruments to promote the application and innovation of most renewable technologies until they become mature and can compete with existing energy technology options (Hojnik & Ruzzier, 2016). For immature technologies, including renewable energy ones, demand subsidies are not as effective as R&D in contributing to cost reductions in renewables (Keyuraphan, et al., 2012).

Permanent renewable energy subsidies are not only an expensive choice to realize mitigation targets, but also a very risky instrument because even a small deviation from the optimal value will lead to a rapid rise in emissions or a loss of welfare (Kalkuhl, Edenhofer & Lessmann, 2013). Therefore, subsidy policy should not been regarded as an optimal choice for the long term. In order to promote the low-carbon transformation of the global economy successfully, governments will need to create fair competing environments for clean energy investment through carbon pricing, enhancing stable and predictable regulatory and investment environments, instead of relying on subsidies to renewable energy industry (Keyuraphan, et al., 2012).

In many cases subsidies or grants are needed to de-risk private-sector investment, price the product at an affordable level, and reduce additional costs (e.g. logistics or security costs) associated with displacement

settings (Rosenbaum, et al., 2015). However, reliance on long-term subsidy and grant funding leaves programmes vulnerable to changes in the funding landscape.

Subsidy Initiatives Gap Analysis

A range of challenges exist that inhibit the uptake and effective management of cleaner energy solutions in refugee camps. These are magnified by a lack of available and appropriate funding that could target the nexus of energy access and humanitarian interventions (Shin et al., 2017).

The current funding gap is significant. In many cases, involving the private sector (both enterprises and investors) is viewed as a way to accelerate delivery of sustainable energy solutions, leverage additional capital, efficiency and expertise, and adopt more sustainable and market-based approaches (Simon, 2016).

In Kakuma, the government is providing tax incentives to producers and importers of renewable energy technologies. The humanitarian agencies are carrying out trainings on sustainable energy geared to change individual attitude in order to stimulate acquisition and adoption of sustainable energy technologies. The dealers of sustainable technologies in the camps on the other hand are offering interest subsidies through pay as you go schemes (PAYGO). Despite these efforts the adoption rate of sustainable energy technologies are low yet there exist limited empirical studies to address this concern. This study is an empirical attempt to fill this gap.

Further, Subsidy initiatives in a humanitarian setting are a recent phenomenon and have scantly been studied on their relationship with the adoption of sustainable energy technology. This study addressed this knowledge gap by conducting a mixed research design from a consumer behavior perspective in order to heighten the knowledge of adoption rates of sustainable energy technology, thus the study influence of subsidy initiatives on the adoption rate of sustainable energy technologies in Kakuma refugee camps.

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Research Design

This research adopted concurrent descriptive cross sectional and correlation research designs. The choice of this research method was primarily to collect qualitative data to illustrate quantitative findings. This enabled the researcher to collect both quantitative and qualitative data that focused on generating detailed information regarding the key aspects.

Study Population

According to UNHCR (2019), as of August, 2019 Kakuma refugee camps had 191,500 refugees. 1000 of them who were trained by SNV on sustainable energy in Kakuma formed the study population. Further, the population included zonal leaders in the camps, lead persons drawn from UNCHR implementing agencies and sustainable energy market organizations.

Sampling Strategy and Sample Size

The current study employed simple random sampling technique to sample refugees in Kakuma refugee camps. Purposive sampling was used to select UNHCR implementing partners. In choosing the sample for FGDs, and observation, census was used. The Slovins statistical formula was employed to obtain the study sample size as follows.

$$n = \frac{N}{1 + N(e)^2}$$

Where; n= sample size, N=Population, e = level of precision

n=1000 / (1+1000 $(0.05)^2$) = 286 respondents

For focus group discussions, census technique was used since the population of interest was smaller. However for interview, 29 lead persons drawn from 42 implementing partners operating in Kakuma were selected. This represents 69 % of the population.

Data Collection Instruments and Procedure

The quantitative tool employed was a structured questionnaire that was applied to 286 refugee respondents. The qualitative tools employed were interview and FGD guides and an observation check list. The instruments were pre-tested in a pilot study at Kalobeyi due to its similarity with camps, to check for their reliability and validity.

For open-ended questionnaires the respondents were required to use their own words to answer questions, whereas in closed-ended questionnaires pre-written response categories were provided. The questionnaires were administered using 'drop-and-pick' method. This provided convenience and efficiency in the process of data gathering.

For key informant interviews, purposive sampling was used to identify respondents through consultation with SNVs in the camps. Only the UNHCR implementing partners whose role were within the interest of the study were chosen for the interview. An interview schedule was used, and before the interview, the interviewer gained a rapport with the respondent. The respondents answered identical questions at individual level to maintain confidentiality and to control bias among the respondents.

Focus Group Discussions (FGD) were used to explore their ideas on ownership and adoption of sustainable cooking and lighting technologies. The topics for discussion were modeled from the research questions, questionnaires and interview schedule. Two FGD were carried out comprising 7 and 6 zonal leaders respectively.

Observation was used to explore the SE technologies in the Kakuma market place. The SE market organization list was provided by the SNV, which is in charge of the energy cluster in Kakuma camps. All the organizations were visited, observation on their technologies made and photographs taken.

Secondary data was used to supplement the primary data collected and identify critical grey areas the study sought to fill. The sources of data reviewed included journals, publications, online reports and statistics from the government ministries such as energy and donor agencies working in Kakuma refugee camp. The secondary data was useful in corroboration of the study findings.

Data analysis

Data was analyzed using Statistical Package for Social Science (version 25) by applying both descriptive and inferential statistical procedures. Descriptive results were presented in tables. Quantitative information was analyzed through statistical procedures. Pearson's correlation analyses was used to explore the association among subsidy determinants of adoption rates of SET and SET adoption rates. The regression model was

tested on how well it fits the data. Fischer distribution test was applied. It was used to test the significance of the overall model at a 5 percent confidence level. The p-value for the F-statistic was applied in determining the robustness of the model. The conclusion was based on the basis of p-value. The statistical significance of the coefficients were determined using the t-statistic. The t-test was used to establish if the correlation coefficient were significantly different from zero, and, hence whether there is evidence of relationship between the two variables. To test the hypotheses, multiple regression model was used. The significance of the regression model was determined using analysis of variance (ANOVA). The significance of each independent variable was also tested. The significance of coefficients were determined using the t-test.

The statistical package for social sciences, SPSS (version 25.0) was used for data analysis.

The linear regression model used was as follows:

$Y=\alpha + \beta_1 X_1 + e$ Equation 3.1

Where:

Y is weight for adoption rates of SET

α is regression constant

β_1 is regression coefficients

X_1 is weight for subsidy initiative

e is stochastic term

Hypothesis were tested at 95% confidence level ($\alpha = 0.05$). A two tailed test were carried out.

Results and Discussion

Descriptive Analysis

Subsidy Initiatives

The mean and standard deviation of the findings on the subsidy initiative influencing the adoption rates of sustainable energy technologies is shown in table 1.

Table 1: Subsidy Initiative

	Mean	Std. Deviation
	Statistic	Statistic
The sensitization of subsidized energy technologies is properly done within the refugee camps	3.55	1.028
I am aware of the subsidy initiatives by the NGO's and the government within the refugee camps	4.60	.944
The government provides direct subsidies to the producers of sustainable energy technologies	4.71	1.080

The amount of the sustainable energy subsidy is sufficient to stimulate access	2.12	1.051
The current subsidy has motivated me to continue using sustainable energy solutions	4.64	.916
I prefer the sustainable energy solutions subsidy timing to be at the beginning phase	4.58	.965

Sensitization of Subsidy Initiative

The sensitization level is not sufficient to cause the adoption of SET as respondents were neutral to the assertion that the sensitization of subsidized energy technologies is properly done within the refugee camps as indicated by a mean of 3.55 and standard deviation of 1.028. The findings imply that despite the fact that refugees have a feeling that sustainable energy technologies are subsidized, this information is not widely disseminated to the users of sustainable energy technologies in the refugee camps.

Presently, the sensitization is carried through demonstration of the working of the technologies within few hours and refugees are left to decide. While this has been convincing at early stages to promote acquisition of SET it fails to foster adoption due to failures of SET associated with quality over time In a study carried out by the Lumina Project on LED torches in East Africa, it was found that 90% of the users experienced quality-related problems during the six-month study period. In 2009, Lighting Africa began testing the quality of solar products available in the African market. The study revealed that 13 out of the 14 Pico PV products in circulation did not pass their quality tests

The researcher during focus group discussions noted that despite sustainable energy technologies in the camp having been subsidized by humanitarian agencies, this subsidy accounts for minimal influence on the sustainable energy integration. This is a result of the fact that the subsidies are not well communicated to the refugees and most of these subsidies cover only acquisition costs and the subsequent use of fuel is left to the refugees. For instance, Bioethanol stoves are subsidized but ethanol fuel is not which makes these subsidies unsustainable in the long run.

When doing an interview, most of the UNHCR implementing partners posited that subsidy initiatives have a significant influence on integration of sustainable energy in refugee camps. However, the current level of sensitization on subsidies is not adequate to influence behavioral change on the refugees, that is, to switch from traditional forms of energy to sustainable energy solutions due to intermittency of sensitization.

The researcher while doing an observation on the SE market organizations in Kakuma noted that the subsidy awareness creation on sustainable energy solutions is minimal thus it fails to lead to behavior change to foster

acquisition and adoption of SET. The subsidy was only communicated by a word of mouth and only upon inquiry.

Generally, there is a great need to improve on awareness creation in the target market of SETs by demonstrating benefits of SET, as well communicating existing subsidy initiatives, the hazards in using dirty fuels to light their homes and cook. Consumer education is essential to overcome hurdles for SET client base, especially in in the refugee camps.

Level of Awareness of Subsidy in Camps

The study revealed high level of awareness of the subsidy initiatives by the NGO's and the government within the refugee camps as indicated by a mean of 4.60 and standard deviation of 0.944 and equally aware that the government provides direct subsidies to the producers of sustainable energy technologies as indicated by a mean of 4.71 and standard deviation of 1.080. Contrary to low level of awareness creation as opposed to high awareness levels in the camp implies refugee are sensitized elsewhere other than by humanitarian agencies. This anomaly is expected since majority of the refugee have mobile phones and thus have access to information. . In countries where the media is free, such levels of awareness are expected as corroborated by the findings of Sampa, (2007) research in Botswana that showed that about 57% of the respondents knew their government policies planned to support the use of SE technologies.

During an interview one of the key informants remarked as follows;

> *Within the Kakuma Camp majority of the households have mobile phones that enable them transact within the camps, keep in touch with their relatives abroad and get access to local information*

Efficacy of Subsidy Initiative in Promoting Acquisition and Adoption of SET

The study revealed the amount of the sustainable energy subsidy is not sufficient to stimulate access as shown by a mean of 2.12 and a standard deviation of 1.051 however the subsidy after acquiring the SET devices is sufficient to allow for adoption as indicated by a mean of 4.64 and a standard deviation of 0.916. The findings imply that sustainable energy technologies are passed on to the refugees at a much lower cost which provides refugees with a feeling that they are highly subsidized. The findings also imply that subsidy activities by donor agencies on sustainable energy products are publicized based on costing of the devices and respondents are made aware that sustainable energy technologies are less costly compared to other alternative sources of energy which have both financial and non-financial implications. Solar home systems have demonstrated benefits to women through savings on kerosene, better quality light, enhanced child welfare, and increased self-respect and empowerment (Winther, Ulsrud and Saini, 2018), but the upfront costs remain a barrier. The findings are supported by a report by the International Sustainable Energy Agency (IRENA), (2017), which found out that the cost of installation and maintenance of sustainable, which was an important stumbling block to mass adoption, continues on a downward trajectory.

The MEI survey of residents in Kakuma I included identification of user preferences and willingness to pay for various stove and fuel options. Only 55 per cent of respondents expressed a willingness to pay for at least $5 for a basic stove lower than the 75 per cent of residents currently using a basic ICS. The researcher opines this could be a case of 'dependency syndrome' and unwillingness to pay for something that respondents believe should be provided for free.

Appropriate Subsidy Time Structure to Stimulate Access and Adoption of SET

The study found that subsidy structure that allows subsidy at the beginning had influence on the adoption rates as refugees preferred the sustainable energy solutions subsidy timing to be at the beginning phase as shown by a mean of 4.58 and a standard deviation of 0.965. The cost of sustainable energy technologies has been defined as the most significant challenge to the adoption. The effects of limited local rebates are felt on all levels of the distribution value chain from the importers, distributors, dealers and refugees. The focus group discussants were of the view that the main obstacle for a further spread of SHSs among refugee in Kakuma is the initial up-front cost. Refugees are used to paying for lighting on a daily basis, purchasing kerosene. Saving up money for the significant investment of an SHS, is for most refugees not possible. Financial capital is scarce which is almost exclusively accessed through remittances

During interview with the lead sector leaders, they were of concurring opinion that the current subsidy of acquiring and maintaining sustainable energy technologies within the refugee set up should be reviewed to ensure all payment are as PAYGO.

Bivariate Analyses

Relationship between Subsidy Initiave and Adoption Rates of SET

Table 2. Presents Pearson's correlation of subsidy initiative and adoption rates of SET.

Table 2: Relationship between Subsidy Initiative and Adoption rates of SET

		Subsidy Initiatives	Sustainable energy integration
Subsidy Initiatives	Pearson Correlation	1	
	Sig. (2-tailed)		
	N	274	
Sustainable energy integration	Pearson Correlation	.184**	1
	Sig. (2-tailed)	.000	
	N	274	274

**. Correlation is significant at the 0.01 level (2-tailed).

The Pearson correlation analysis found a weak positive correlation between subsidy initiative and adoption rates of SET ($r=0.184$, $P<0.001$). This implies that an increase in subsidy initiaves of sustainable energy would lead to an increase in the sustainable energy integration in refugee camps. The study findings agree with the Karytsas S, and Theodoropoulou, E. (2014) who found that subsidy influence publics' adoption on the different forms of renewable energy sources

Model summary

Table 3. Subsidy Initiative and Adoption rates of SET Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.935[a]	.764	.717	3.559

a. Predictors: (Constant), Subsidy Initiatives

In the regression aanalysis conducted shown in table 3, the goodness of fit for the regression between subsidy initiative and adoption rates of SET was significant, $F(1,273) = 887.780$, $P<0.001$, $R^2 = 0.764$. R^2 squared of 0.764 indicates that 76.4% of the variations in SE integration is explained by the variations in subsidy initiative. This implies that 23.6% of the unexplained variations in SE integration is accounted for by the other variables outside the study scope.

ANOVA

Table 4: Subsidy Initiative and Adoption rates of SET Model Validity

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1668.176	1	1668.176	887.780	.000[b]
	Residual	513.073	273	1.879		
	Total	2181.249	274			

a. Dependent Variable: Adoption Rates of SET

b. Predictors: (Constant), Subsidy Initiatives

The ANOVA test conducted as presented in table 4 showed that the overall model was significance indicated by an F statistic of 887.780 at $P<0.001$.

Significance of coefficients

Table 5. Subsidy Initiative and Adoption rates of SET Regression Weights

		Unstandardized Coefficients		Standardized Coefficients		
Model		B	Std. Error	Beta	t	Sig.
1	(Constant)	6.769	1.223		5.535	.000
	Subsidy Initiatives	.198	.054	.184	3.644	.000

a. Dependent Variable: Adoption rates of SET

Regression analysis (table 5) on the subsidy initiatives coefficient show that subsidy initiatives factors uniquely contributes significantly to sustainable energy adoption rates ($P<0.001$). This imply that one positive unit change in subsidy initiatives would lead to a change in SE integration at the rate of 0.198. The predicted value of adoption rates of SET when all other variables are 0 is 6.769.The fitted equation is as shown below;

$Y= 6.769 + 0.198X_{1} + \varepsilon$

Based on the qualitative data, it was observed that subsidy initiatives positively influence sustainable energy integration in Kakuma refugee camps. The researcher during focus group discussions noted that despite sustainable energy technologies in the camp having been subsidized by goverments, humanitarian agencies and dealers, the subsidy accounts for minimal influence on the sustainable energy integration. This is a result of the fact that the subsidies are not well communicated to the refugees and most of these subsidies cover only acquisition costs and the subsequent use of fuel is left to the refugees. For instance, Bioethanol stoves are subsidized but ethanol fuel is not which makes these subsidies unsustainable in the long run.

Conclusion

This study has found conclusive evidence that subsidy initiatives factors contribute significantly to adoption rates of sustainable energy technologies. This imply that one positive unit change in subsidy initiatives factors would lead to a change in adoption rate of sustainable energy technology. Therefore UNHCR should improve sensitization on existing subsidies and advocate the structuring of the subsidy to allow access at the outset and adoption in the long run. In so doing subsidy will an incremental role in the adoption of SET.

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