Influence of Standardization on the Adoption of Concentrated Solar Technology by Tea Factories Run by KTDA in Kenya

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Abstract
This study sought to assess the effect of standardization on the likelihood of the adoption of Concentrated Solar Power Technology (CSPT) by the KTDA run tea factories in Kenya. The study was guided by the International Organization for Standardization (ISO) Guide on Standardization

The target population was all factory unit managers of the 66 tea factories under the management of KTDA. The study was a cross-sectional survey using a quantitative approach for descriptive and inferential statistical outcomes. Data collection was by a structured questionnaire and binary logistic regression model was used to analyze the data. The standardization model was found to be statistically significant in influencing the likelihood of the adoption of CSPT by tea factories managed by KTDA, with a Chi2 p-value of 0.0222 and McFadden's R2 of 0.2277. This meant that CSPT standardization was likely to influence the adoption of CSPT among tea factories managed by KTDA with a 95% confidence level. These findings were consistent with the propositions of the (ISO) Guide on Standardization. It was also consistent with findings of other studies and projects such as the standardization initiatives for CSH systems and CST technologies in India, and standardization of broadcast TV technologies in the US.

Keywords: Concentrated solar power technology, Adoption, factory, Standardization

1. Introduction

1.1 Energy Challenge Facing Tea factories in Kenya

Kenya has a tea sub-sector that has been faced by a significant need for process heat, with a temperature range of 60-80oC (Rawlins & Ashcroft, 2013). By 2019 there were 55 Kenyan tea factories owned by small scale farmers but managed by the Kenya Tea Development Agency (KTDA) (Suryani A, Bezama A, Mair-Bauernfeind C, Makenzi M, &Thrän D, 2022). These companies ran by KTDA have been complaining of high and rising costs of fuel (Rawlins & Ashcroft, 2013). Almost every of these factories have been using fuel wood as their source of process heat energy. On average each tea factory would use 20,000 cubic meters of firewood per year, which translates to about 60,000 trees. However, wood supply has been declining as trees and forests get depleted, and costs of trees have also been rising.

This setup necessitated an initiative by thirty-four (34) of the companies to come up with an own tree planting program. Growing of eucalyptus trees in plantations on the factories land was identified as the most viable, self-reliant and sustainable source of wood fuel. This initiative has greatly alleviated the fuel challenge for the factories. However, inadequate land and the long gestation period have been a challenge for sustainable wood production for the rising demand of thermo energy (Suryani A. at al, Bezama A, 2022).

During the same period seventeen (17) factories complained of rising oil prices they were also using oil. They were reported to have made use of 3.6 million litres of oil in 2011, that resulted in CO2 emissions of about 14 ktCO2 (Rawlins & Ashcroft, 2013). These factories were therefore, reported to be seeking alternatives of fuel oil as their source of heat energy.

At the same time, the study by Carbon Trust was promoting the viability of Concentrating Solar Power Technology (CSPT) in Kenya (Rawlins & Ashcroft, 2013). The study singled out the tea industry as a suitable beneficiary of CSPT. It suggested that the tea factories could replace 30% of their thermo energy needs by taking up CSPT. CSPT system use mirrors to focus sunrays on a receiver, which transforms and transfers the sun energy to a heat transfer fluid which then supplies heat for direct use in an industrial operation. (IEA-ETSAP & IRENA 2015).

In comparison to use of oil and fuel wood, CSPT helps in climate change mitigation by reducing carbon emissions from the factories (Rawlins & Ashcroft, 2013). Farther, it improves energy security by restoring the depleting forest resources, and help the factories save about thirty percent (30%) of their heat energy costs. Beyond these, CSPT would reduce deforestation in the Kenya and reduce health hazards caused by use of oil and wood fuels in the industry. Though the solar heat technologies have demonstrated a strong technical potence, and high promise for economic gains for factory processes, their adoption has been very low (IEA-ETSAP & IRENA, 2015).

Due to CSPT benefits, many newly industrializing countries have embraced the technology. India has made efforts for a strong CSPT utilization, making use the country's good solar insolation (Hu and Wu, 2013). Other countries where the technology is gaining up fast are South Africa, Saudia Arabia, Qatar and Morocco just to mention a few.

Kenya has a solar energy resource estimated to be 4 to 6 kWh per square meter per day of solar isolation, creating a credible bases for CSPT viability as a sustainable source of heat energy for

the factories in the country. A prototype parabolic trough solar concentrator for steam Production was developed at Jomo Kenyatta University of Agriculture and Technology (JKUAT) (Kawira et al., 2012). It was able to generate a maximum temperature of steam of 248.3^0C and average temperature of steam of 150^0C. These showed that production of energy from the sun flux was a viable undertaking in Kenya.

Despite these strong recommendations for application of CSPT in the tea sector in Kenya tea factories, by 2013 there was no evidence of any installed CSPT facility of the technology among the tea factories (Rawlins & Ashcroft, 2013).

1.2 Problem Statement

Heat energy has been a key input for tea manufacturing process and energy costs made up to thirty percent (30%) of the gross tea processing costs. About 90% of the tea factory energy requirements have been for process heat for withering and drying. Kenya tea factories faced the challenge of coming up with a sustainable source of process heat energy. Wood and oil sources they have been making use of have not been sustainable due to their high and rising costs, depletion of natural resources and the negative impact on environment. This scenario threatened future survival of the tea factories, the country's foreign exchange earnings and the incomes and livelihood of the over 600,000 small scale tea farmers, whose 80% earnings have been from tea.

Use of CSPT has been highly recommended as an alternative source of heat energy for the tea factories. It would be cheaper, more reliable, environmentally friendly and would enhance the

survival of the tea industry and the livelihood of the farmers. Despite these promising qualities and expected benefits of CSPT, by 2013 CSPT had not been taken up by any of the 66 tea factories managed by KTDA.

Standardization has been found to be a key factor in adoption of new technologies. It gives assurance that a product or service delivers as promised, and that it works as per specifications. It also gives the needed assurance of the product reliability, durability and safety. This would build confidence and trust in renewable energy technologies and their supply chain players. This study sought to find out the extent to which standardization of CSPT could be used to influence the adoption of CSPT by the tea factories managed by KTDA in Kenya.

1.3 Research Objectives

This study was guided by the following objectives.

General Objective

To assess the effect of CSPT standardization on the likelihood of the adoption of CSPT by the KTDA run tea factories in Kenya.

Specific Objectives

This study sought to achieve the following specific objectives:

i) To analyse the effect of CSPT Quality assurance on likelihood of the adoption of CSPT by the KTDA run tea factories in Kenya.
ii) To assess the effect of CSPT installation procedure standards on the likelihood of the adoption of CSPT by the KTDA run tea factories in Kenya.
iii) To assess the effect of use of KEBS marks of quality on the likelihood of the adoption of CSPT by the KTDA run tea factories in Kenya.
iv) To evaluate the effect of ISO certification on the likelihood of the adoption of CSPT by the KTDA run tea factories in Kenya.
v) To assess the effect of KEREA accreditation on the likelihood of the adoption of CSPT by the KTDA run tea factories in Kenya.

1.4 Research Hypotheses

This study was be guided by the following null hypotheses.

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General Objective.

H_{06}: The independent variables (Quality assurance, installation procedure standards, KEBS marks of quality, ISO certification and KEREA accreditation) do not have a significant combined effect on the likelihood of the adoption of CSPT by the KTDA run tea factories in Kenya.

Objective One

H_01: There is no significant relationship between CSPT Quality assurance and likelihood of adoption of CSPT by the KTDA run tea factories in Kenya.

Objective Two

H_02: There is no significant relationship between CSPT installation procedure standards and likelihood of adoption of CSPT by the KTDA run tea factories in Kenya.

Objective Three

H_03: There is no significant relationship between use of KEBS marks of quality and likelihood of adoption of CSPT by the KTDA run tea factories in Kenya.

Objective Four

H_04: There is no significant relationship between CSPT ISO certification and likelihood of adoption of CSPT by the KTDA run tea factories in Kenya.

Objective Five

H_05: There is no significant relationship between CSPT KEREA accreditation and likelihood of adoption of CSPT technologies by the KTDA run tea factories in Kenya.

1.5 Theoretical Framework

International Organization for Standardization (ISO) Guide on Standardization

This study was based on the guide on standardization. ISO defined a standard as a document that furnish rules, guidelines or characteristics of activities or their expected results, for the purpose of attaining optimum level of order in a given context (ISO, 2013). A standard for a specific product is, therefore, a document that sets out provisions that enable reduction of unnecessary variety in the marketplace. This may result in an organization enjoying economies and subsequent lower unit costs of production. The lower costs should eventually (in efficient market conditions) trickle down to the final consumer in the form of lower product prices. A standard has also been explained as set of conditions, or requirements that a component of a system or technology must meet in order to perform effectively, while standardization is the pursuit of those set elements so as to develop standards (Adhiarna& Rho, 2009).

Use of standards provide an assurance that product or service offered in the market are fit for a designated purpose, are safe and have value for their price (IRENA, 2013; ISO, 2013). A key element of this assurance is to ensure that a product or service delivers as promised, and that it works as per specifications. There is also need for assurance of the product reliability, durability and safety. Several times set standards and their conformity on sustainable energy technologies has been the driving force for switching from use of the inefficient and polluting fossil fuel energy sources. This is attained through building confidence and trust in renewable energy technologies and their supply chain players. Further, standards enable technicians and users of renewable energies to fathom the technologies and their installation and operation procedures, thereby promoting self-reliance and less supervision. This is attained through the establishment of clear standards and best practices on product designs, installations and maintenance of renewable energy systems. International standards for rural electrification that have been in place for some time now are a good example of such practice.

Further, standards give an effective platform that facilitate information flow, comprehension of product designs, production and service requirements, as well as setting up common rules and requirements (IRENA, 2013). Beyond this, the standardization process has proven to be an effective tool for supporting energy reforms, energy regulations, energy technologies trade, energy technologies performance and environmental improvements. Last but not least international standards on energy technologies enhance trading opportunities across the world and minimize dumping practice instances of poor-quality goods.

Despite the above discussed gains of standardization, the practice has been criticized for being complicated, very formal, tardy and time wasting (IRENA, 2013). Further it is said to pose several challenges for industries in the third world that may not be able to abide to the international standards and may, therefore, lose market share to import products. A recent report published by the United Nations Foundation on achieving universal energy access by 2030 underlined the importance of standardization. It posited that without standardization, energy technologies are likely to be unsafe, have poor performance, and easily fail in their young market (IRENA, 2013). It further said that renewable technologies that fail to perform because of poor quality or installation create negative attitudes in the minds of consumers and destroy the renewable energy technologies market.

To ensure products meet set standards they are subjected to Conformity assessment procedures. These are technical processes that include testing, verification, inspection and certification. These procedures ascertain that the technologies meet the requirements stipulated in regulations and standards (IRENA, 2013; ISO, 2013). Certification for adherence to standards is done through verification and auditing processes that are grounded on benchmarking against criteria and scheme documents. The verification and auditing can be done by an organization's employees or can be outsourced to conformity assessment organizations which give an objective assessment. Finally, there is the third-party conformity assessment. This is conducted by independent certification organizations which include certification, inspection and laboratory accreditation organizations. These organizations have themselves to be accredited, for the particular testing schemes they offer, by an accreditation organization authorized to do so under international standards and agreements. Good quality products are often attained through peer assessment, which replaces conformity certification, inspection bodies and laboratories. These theoretical contributions by ISO and IRENA provided a base for analysis of standardization concerns in the adoption of CSPT among tea factories managed by KTDA.

1.6 Empirical Literature Review

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As explained earlier, standardization provides credence and belief in sustainable energy technologies and all the players in their supply chain. Several standardization initiatives have been remonstrated in the solar concentrators for process heat applications promotion project in India. To minimize the fear of failure to perform of CSH systems, a system of continuous monitoring of the CSH systems installed were set at 15 places (Akker & Aggarwal, 2015). Adequate testing equipment, some mobile and others static, were set in these places for the monitoring. Performance data obtained from these sites gave credibility information to potential CSH users which increased their confidence in the CST technologies. The manufacturers also benefited from the information as they used it for product improvements. BIS standards were also established to help in the testing of procedures. Beyond these, performance norms for the several CSTs were made availed for the different heat requirements and for different regions of the country. In general standards were hinged on compatibility, minimum quality, safety, variety reduction and information content.

In the same project the National Initiative of Solar Energy (NISE) and Savitribai Phule Pune University (SPPU) established laboratories for testing and certification of CST technologies (Singh, Kiran & Pathak, 2017). Through these the ministry (MNRE) has made it mandatory for suppliers to test their CST systems to be accepted as channel partners. This ensures that only quality products are supplied to customers which in-turn boost the confidence of customers in the CST systems. Test data obtained is used to set product benchmarks.

A regularly cited illustration of importance of standardization is the US solar heat industry. In the 1970s, not having of standards for thermal technologies and for installation procedures, have been blamed for a setback in the diffusion of solar technology for decades (IRENA, 2013). Even though the solar heat market was moribund at the time, lack of serious emphasis for standardized quality delivery, has been cited as a major culprit for poor uptake of solar thermal systems in the US for the last four decades.

Other studies have also emphasized the role of standardization in new technologies adoption. A study in the US on standardization and the adoption of broadcast TV technologies aimed at finding out the effects of standards setting on the adoption of broadcasting technologies (Kim, 2012). The study established that standardization issues, especially compatibility and agreement between stakeholders were important in adoption of the TV technologies. Committee based and defacto standards for TV technologies were found to contribute to faster rollout of new broadcast services. Overall conclusion of the study was that standardization creates a basis for development of new technologies. A similar study was done on the impact of standardization on adoption of IT technologies among 340 organizations from across the world (Grantz& Turner, 2002). The study focussed on the benefits the organizations gained from using standardized systems. The study reported lower costs and higher speeds of adoption of the technologies as the gains from standardization. Standardization is also highlighted in a study on standardization and global adoption of radio frequency identification (RFID) technologies in developing countries (Adhiarna& Rho, 2009). The study focused on identifying strategic issues concerning RFID standards and their importance in developing countries. Harmonization of RFID standards was recommended as the second-best solution to ensure rapid adoption among various industries.

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1.7 Conceptual Framework

The model of this study is presented as a relationship between CSPT standardization and CSPT adoption. CSPT adoption is conceptualized as the dependent variable and CSPT standardization is presented as the independent variable with five covariates. The model is illustrated in Figure 1 below.

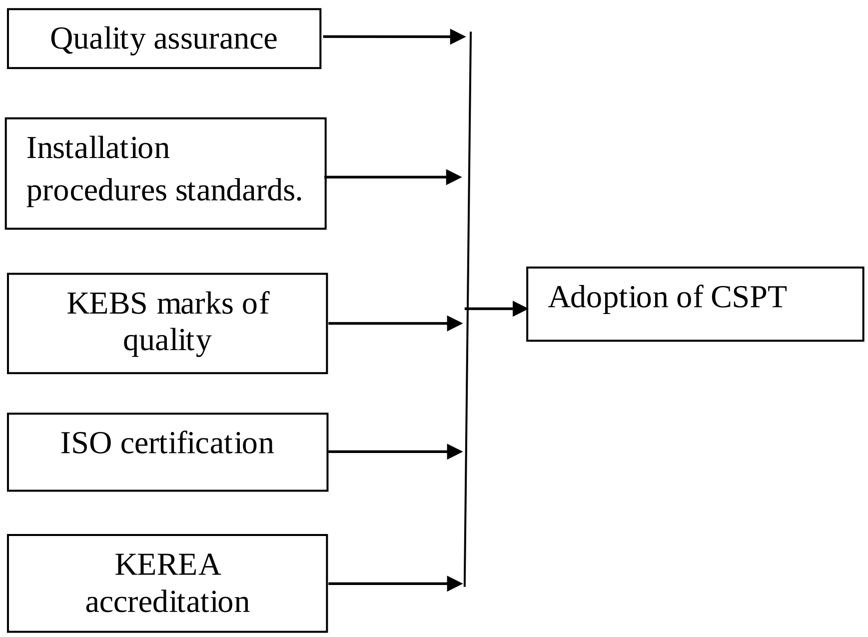

Figure 1. Conceptual Framework

2. Method

2.1 Research Design

This study used a positivism philosophy which emphasizes use of observable social reality get law-like generalizations (Saunders et al, 2009). The study was a cross-sectional survey to attain descriptive and explanatory purposes. This approach of survey was chosen because it enables the researcher to get data on practices, situations or views at one point in time by use of questionnaires or interviews, that can be analyzed to detect patterns of association (Bryman, 2012).

2.2 Target Population.

The target population was sixty-six (66) tea factories in Kenya managed by KTDA. The 66 tea factories were spread out in 13 counties in the country. The target respondents of this study were sixty six (66) unit managers of the tea factories run by KTDA.

This population was considerably small and therefore no sampling was done but a census was conducted instead. Census is an investigation of all the members that make up a population (Zikmund et al, 2013). In the study, therefore, the sixty-six factories managed by KTDA were studied. Data collection for the study was done by use of questionnaires. Drop and Pick technique was applied with the target population.

2.3 Data Analysis

Data was analyzed using descriptive statistics and inferential statistics obtained through logistic regression procedures. Firth penalized logistic regression model was selected for this study. The model offers solution to the problem of separation in logistic regression and small sample biases (Rahman &Sultsna, 2017; Eyduran 2008).

The proposed relationship between CSPT standardization and the adoption of CSPT was formulated using CSPT standardization elements (Quality assurance, Installation procedures standards, KEBS marks of quality, ISO certification, and KEREA accreditation) as covariates. These developed into the following model:

$$\text{Logist}f(\text{CSPT Adoption}) = \beta + \beta_1 X_1$$

$$= \boldsymbol{\beta + \beta_1 QualA + \beta_2 IstalP + \beta_3 KEBsM + \beta_4 ISOstd + \beta_5 KERaccr} \qquad \textbf{(i)}$$

Where β = is constant level of adoption not influenced by the regressor, X_5 = CSPT technology standardization, $\beta_1 \ldots\ldots \beta_5$ are regression parameters, while QualA, IstalP, ISOstd, KEBsM, and KERaccr, are standardization elements quality assurance, installation procedures standards, ISO certification, KEBS mark, and KEREA accreditation.

3. Results

Adoption of CSPT by Tea Factories

Adoption process has five stages, namely knowledge, persuasion, decision, implementation and confirmation stages. The managers were requested to indicate at what stage their factories were in in this adoption process. Sixty of the factories (91%) strongly agreed their factories had not made any step towards the adoption of CSPT. They did not have any CSPT information in the industry. This meant that of over ninety percent of the factories had not begun the CSPT adoption process, a stage that is known as Prior. The remaining six of the factory managers had knowledge of the CSPT technology, and three of them (4.5%) had made a decided to adopt the CSPT technology. However, the decision had not been implemented. They were still going through procurement logistics. The last three factories were aware of CSPT, its gains and likely challenges. They were evaluating the case of adopting but had not decided. These results are illustrated in Table 1.

Table 1: Factories CSPT Adoption Stage

Factory Adoption Status	Percentages SD	D	DK	A	SA	Mean	Std. Dev.

The factory management has made no effort in CSPT adoption process (Prior)	9	0	0	0	91	4.64	1.149
The factory management is in information search stage of CSPT adoption process	100	0	0	0	0	1.00	0
The factory management is in information evaluation stage of CSPT adoption process	95.5	0	0	0	4.5	1.18	0.833
The factory management has made a decision to adopt CSPT technology	95.5	0	0	0	4.5	1.18	0.833
The factory management has installed CSPT technology	0	0	0	0	0	0	
The factory management has installed CSPT technology and is now in post installation evaluation	0	0	0	0	0	0	
Average						**2.00**	**1.732**

This distribution of the tea factories in according to their CSPT adoption status was tested for normalcy. This involved testing skewness and kurtosis of the data. Skewness is measures data asymmetry whereby normal distribution has a skewness value of zero (Hippel, 2010). Data distribution whose skewness value is two times or more of the skewness standard error is taken to be asymmetric, and therefore not normal. Skewness for the CSPT adoption by tea factories data calculated value was 2.809, with a standard error of 0.295. The skewness value is almost ten times the standard error and therefore means that the data on CSPT adoption status of the tea factories is not normally distributed.

Kurtosis refers to the extent to which data values cluster around a central point. A normal data distribution kurtosis has a value of zero. Any significant difference from zero reflects a distribution that is not normal. The tea factories data on CSPT adoption was scored at 6.9. This score supports the skewness results, and leads to a conclusion that the factory CSPT adoption status data is not normally distributed. These findings are illustrated in Table 2.

Table 2: Factory CSPT Adoption Status Skewness and Kurtosis

	N	Mean	Std. Deviation	Skewness		Kurtosis	
		Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
CSPT Adoption	66	1.2727	.75540	2.809	.295	6.900	.582

The factory CSPT adoption status was also examined using a Q-Q plot (quantile-quantile plot). This is a graphical measure used to test gauge normality of a data set. It shows at a glance if normality assumption is true. A normal distribution results in a straight-line plot, while a curved plot implies data that is not normally distributed. The Q-Q plot for the factory CSPT adoption status data is illustrated in Figure 2 below. The observed values plots are way off the normal distribution expected plot. This confirms the factory CSPT adoption status data is not normally distributed.

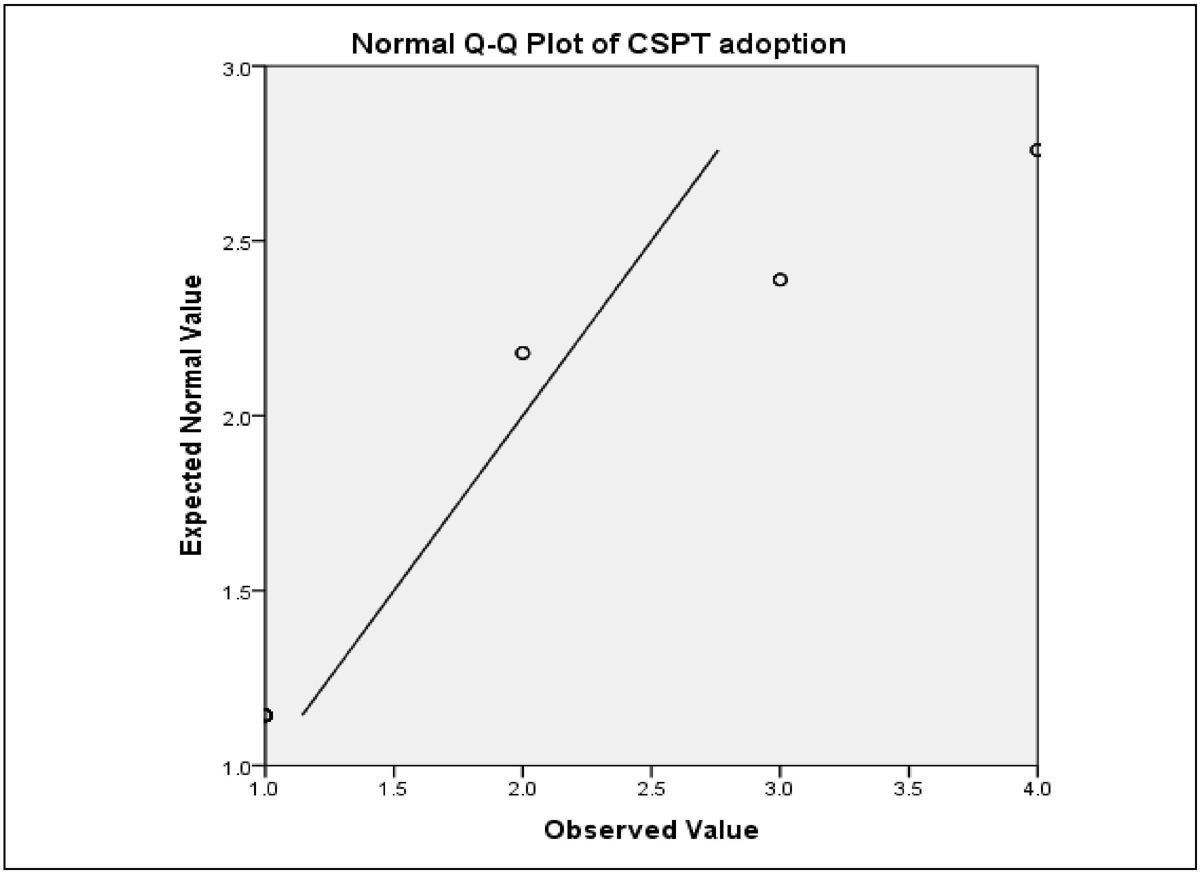

Figure 2 Factory CSPT Adoption Status Q-Q Plot

CSPT Standardization and Likelihood of CSPT Adoption

The last variable investigated in this study was CSPT standardization and its likelihood to influence the adoption of CSPT among tea factories run by KTDA. The elements of CSPT standardization addressed were quality assurance, assurance of installation procedures, KEBS mark of quality, ISO standardization, and KEREA accreditation. The descriptive and inferential findings are discussed in the following sections.

Descriptive Statistics for CSPT Standardization.

The respondents gave their views on the above-mentioned elements of CSPT standardization that are likely to influence them in making a decision to adopt CSPT. Their responses are detailed in Table 3.

Table 3: Managers Responses on Standardization Elements Preferred

	Percentages					**Mean**	**Std.**
Elements of Standardization	**SD**	**D**	**DK**	**A**	**SA**		**Dev.**
Needed/will need assurance on the quality of the CSPT equipment.	0	0	0	59	41	4.40	0.498
Needed/will need assurance of standard installation procedures of the CSPT equipment.	0	0	0	55	45	4.45	0.479
KEBS mark of quality for imported goods (ISM) influenced/will influence the factory management decision to install CSPT.	0	0	0	58	42	4.40	0.498
ISO/TC 180 solar energy standard influenced/will influence the factory management decision to install CSPT.	0	0	0	58	42	4.40	0.498
KEREA accreditation influenced/will influence the factory management decision to install CSPT.	0	0	0	59	41	4.41	0.495
Average						**4.412**	**0.197**

All the elements of CSPT were scored very highly with all the managers approving standardization would enhance the adoption of CSPT, whereby all the managers either agreed or strongly agreed. Quality assurance as an influencer of adoption of CSPT was strongly approved by 41% of the respondents while the balance 59% just agreed. Need for assurance of installation procedures, ISO certification, KEBs marks of quality and KEREA accreditation, all had 'agree' approvals by over 50% and 'strongly agree' approvals by over 40% of the respondents. Each of these elements of standardization scored a mean of over 4.4 out of 5, and their overall mean was 4.412. This indicates that the respondents felt all the elements of CSPT standardization are almost equally important in assuring them of the CSPT and its workability, and would therefore be required before they could make an adoption decision.

Inferential Statistics on Standardization and CSPT Adoption.

The relevant objective for this section was to assess the likelihood of CSPT technology standardization to influence the adoption of CSPT by Kenyan tea factories run by KTDA. The elements of CSPT standardization investigated were quality assurance, assurance of installation procedures, KEBS mark of quality, ISO standardization, and KEREA accreditation. Data

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collected on these elements was regressed against the response variable (CSPT adoption) using Firth logistic algorithm. Regression analysis results are detailed in Table 4.

Table 4: CSPT Standardization & Likelihood to Enhance Adoption of CSPT

N=66 Model: Firth Logistic regression (logit) N of 0's: 63 1's: 3 (Standardization)

Penalized log likelihood = 4.27121 Prob> chi^2 = 0.0222 McFadden R^2=0.2277

	Const.B_0	**Quality**	**SIP**	**KEBS**	**ISO**	**KEREA**
Estimate	0.76685	2.375609	0.363614	0.592941	1.77454	1.732070
p-value		0.02631	0.04728	0.04524	0.03143	0.02991
Odds ratio (unit ch)		10.7575	1.4385	1.8093	5.8975	5.6523

The model scored a McFadden's R^2 of 0.2277. This falls within the 0.24 – 0.4 range of good model fit. The model thus fits the data and it can be used to interpret the relationship between standardization and CSPT adoption. The model was also statistically significant with a Chi^2 score of 0.0222, which is below 0.05 the acceptable p-value at 95% confidence interval. This means that CSPT standardization is likely to influence the adoption of CSPT among tea factories managed by KTDA with a 95% confidence level. This implies the fifth study hypothesis, which stated that 'There is no significant relationship between CSPT standardization and likelihood of adoption of CSPT technologies among the Kenyan tea factories run by KTDA', is rejected. All the elements of CSPT standardization (quality assurance with p-value of 0.02631, assurance of installation procedures with a p-value of 0.04728, KEBS mark of quality with a p-value of 0.04534, ISO standardization with a p-value of 0.03143, and KEREA accreditation with a p-value of 0.02991) were found to be significant, all scoring p-values of below 0.05. This means that all the five elements of CSPT standardization are likely to influence adoption of CSPT by tea factories managed by KTDA at a 95% confidence level. Therefore, the model for relationship between CSPT standardization and adoption of CSPT technologies among the Kenyan tea factories run by KTDA expressed in equation (i) is replaced by equation (ii).

$$\textbf{Logist}f\textbf{ (CSPT Adoption)} = \beta + \beta_1 X_1$$

$$= 0.766 + 2.376QualA + 0.364IstalP + 0.593KEBsM + 1.775ISOstd + 1.732KERaccr \quad \textbf{(ii)}$$

Odd ratios for the different elements of standardization were also computed. Quality assurance had the highest ratio of 10.7575. This ratio implies that a unit change in quality assurance will influence likelihood of CSPT adoption 10.7575 times, all other factors remaining constant. The second influential variable was ISO certification with an odd ratio of 5.8975, followed by KEREA accreditation with an odd ratio of 5.6523. The last two were KEBS mark of quality with an odd ratio of 1.8093 and standardization of installation procedures with an odd ratio of 1.4385.

4. Discussions

The above results suggest a high importance of standardization of the new technology to enhance chances of its adoption. Generally, the managers would seek assurance of the quality of the product before they can think of installing it. More particularly they would wish to have the product bear the KEBS mark of quality for imported goods, have suppliers be ISO certified, and the technology be approved by KEREA (the local association of manufacturers and dealers in renewable energy technologies). This strong requirement of standardization is highly emphasized in previous initiatives to promote adoption of CST technologies. In the 'Market Development and Promotion of Solar Concentrators for Process Heat Applications in India' (Akker & Aggarwal, 2015) project testing facilities were installed for monitoring CSH applications. BIS standards were put in place for compatibility, safety and variability reduction. Further a laboratory for testing and certification of CSH technologies was set up at Pune University. The ministry (MNRE) also made it mandatory for suppliers to test their CST systems to be accepted as channel partners. These are initiatives very much corresponding to those suggested by the tea managers, only they were specific to India. Nevertheless, ISO certification does not seem to have been considered in the Indian case.

Singhal (2017) in a report addressing barriers for accelerating the growth of CSTs in India claimed that lack of standards for measuring performance creates lack of confidence in CST systems in potential customers. To help raise confidence, therefore, he reported that test facilities (mobile and immobile) had been established. Test standards for materials and components of CSTs had also been established. This are measures in the direction of this study's respondents' views. This is also supported by Choudhury (2014) when commenting on CSTs application in industries. She identified a key challenge of use of CSTs in industries was quality and standards. She said that market adoption is simplified when the customers have reliable and trustworthy sources of CST products. She highly recommended steps be put to ensure CST systems aligns to standards defined to central authorities. This well meshes with findings of this study where KEBS, ISO, and KEREA would be the central authorities of reference.

References

Adhiarna, N., & Rho, J. J. (2009). Standardization and Global Adoption of Radio Frequency Identification (RFID): Strategic Issues for Developing Countries. *Korea Advanced Institute of Science & Technology; IEEE DOI 10.1109/ICCIT.2009.300*

Akker, J., & Aggarwal, D. (2015). *Market Development and Promotion of Solar Concentrators for Process Heat Applications in India*: Mid-Term Review of the UNDP/GEF Project. India: UNDP.

Bryman, A., (2012). *Social Research Methods (4th Edition).* New York: Oxford University Press.

Choudhury, R. R. (2014). CST for Industrial Applications: An Industry Perspective. *SUNFOCUS Volume 2, Issue 2, December 2014*; New Delhi, India: SVS Press,.

Grantz, J., & Turner, V. (2002). *Standardization*: *The Secret to IT leverage*. Retrieved from www.idc.com

Eyduran, E. (2008). Usage of Penalized Maximum Likelihood Estimation Method in Medical Research: An Alternative to Maximum Likelihood Estimation Method. *JRMS/ November & December 2008; Vol 13, No 6. P 325-330, www.mui.ac.ir.*

IEA-ETSAP, & IRENA, (2015). *IEA-ETSAP and IRENA Technology Brief E10* Retrieved from http://www.etsap.org – www.irena.org

International Renewable Energy Agency. (2013). *International Standardisation in the Field*

International Organization for Standardization. (2013). *National Standards Bodies in Developing Countries, Fast Forward Series*, 2ndedition, ISO Central Secretariat, Genève Switzerland, Webwww.iso.org ISBN 978-92-67-10582

Kawira, M., Kinyua, R., & Kamau, J. N. (2012). A Prototype Parabolic Trough Solar Concentrators for Steam Production. *JAGST Vol. 14(2) 2012*. Kenya, Jomo Kenyatta University of Agriculture and Technology.

Kim, H., (2012). *Standardization in technology adoption: A comparison of broadcast TV cases*, 19th ITS Biennial Conference 2012, Bangkok, Thailand, 18-21 November 2012: Moving Forward with Future Technologies: Opening a Platform for All

Rahman, M. S., & Sultana, M., (2017). Performance of Firth and Log-F Type Penalized Methods in Risk Prediction for Small or Sparse Binary Data.*BMC Medical Research Series, BMC. https://doi.org/10.1186/s12874-017-0313-9*

Rawlins, J., & Ashcroft, M. (2013). *Small-scale Concentrated Solar Power: A review of current activity and potential to accelerate deployment*. Stamford, London: Carbon Trust.

Saunders, M., Lewis, P. & Thornhill, A. (2009). *Research Methods for Business Students*, 5th edition. Essex, Enland: Pearson Education limited.

Singh, S. K., Kiran, D., & Pathak, A. (2017). CST Test Centres- Supporting CSH programme of MNRE. *SUNFOCUS Volume 4 Issue 3 Jan-March 2017*, New Delhi, India: SVS press.

Singhal, A. K., (2017). Impact of UNDP-GEF CSH Project in Addressing Barriers for Accelerating the Growth of CSTs. *SUNFOCUS Volume 4 Issue 3 Jan-March 2017*, New Delhi, India: SVS press.

Singh, S. K., Kiran, D., & Pathak, A. (2017). CST Test Centres- Supporting CSH programme of MNRE. *SUNFOCUS Volume 4 Issue 3 Jan-March 2017*, New Delhi, India: SVS press.

Singhal, A. K., (2017). Impact of UNDP-GEF CSH Project in Addressing Barriers for Accelerating the Growth of CSTs. *SUNFOCUS Volume 4 Issue 3 Jan-March 2017*, New Delhi, India: SVS press.

Suryani A., Bezama A., Mair-Bauernfeind C., Makenzi M., &Thrän D., (2022). *Drivers and Barriers to Substituting Firewood with Biomass Briquettes in the Kenyan Tea Industry*; Sustainability 2022, 14(9), 5611; https://doi.org/10.3390/su14095611

Zikmund, W.G., Babin, B.J., Carr, J.C., & Griffin, M. (2013). *Business Research Methods*, 9th Edition, Canada: South-Western, Cengage Learning.