DETERMINANTS OF THE LIKELIHOOD OF ADOPTION OF CONCENTRATED SOLAR POWER TECHNOLOGY BY TEA FACTORIES IN KENYA

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DECLARATION

This thesis is my original work and has not been presented for the award of a degree in any other University for examination.

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DEDICATION

I first dedicate this thesis to my late parents Mr. Ezekiel Magu Muchunu and Mrs. Ziporah Wairimu Magu for all sacrifices they made to see me grow and prosper. This work is also dedicated to my wife Njeri, my daughters Wairimu & Waithira, and my son Magu whose substantial time and other resources were diverted for this study.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABREVIATIONS AND ACRONYMS

AC	Absorption Capacity
ADB	Asian Development Bank
ANOVA	Analysis Of Variance
ASBE	Association for Small Business & Entrepreneurship
CD	Compact Disc
CHP	Combined Heat and Power
CL	Collateral
CO_2	Carbon Dioxide
CRIG	Cocoa Research Institute of Ghana
CSH	Solar Concentrating Heat
CSP	Concentrated Solar Power
CSPT	Concentrated Solar Power Technology
CST	Solar Concentrating Technology
DPR	Detailed Project Report
DVD	Digital Versatile Disc
EE	Energy Efficiency
Energy4ALL	Energy for All
ESTIF	European Solar Thermal Industry Federation
ETC	Evacuated Tube Collectors
ETSAP	Energy Technology Systems Analysis Program
FAO	Food and Agriculture Organization
FEP	Formal Education Programs
FPC	Flat-Plate Collectors
GBTs	Green Building Technologies
GDP	Gross Domestic Product
GEF	Global Environment Facility
GG	Grants from Government
GHG	Green House Gases
GOK	Government of Kenya
GW	Gigawatts
IDC	International Data Corporation
IEA	International Energy Agency

IFEP	Informal Education Programs
IISD	International Institute for Sustainable Development
IPCC	Intergovernmental Panel on Climate Change
IRENA	International Renewable Energy Agency
ISC	Insurance Schemes
ISO	International Organization for Standardization
ITC	International Trade Centre
JICA	Japan International Cooperation Association
JKUAT	Jomo Kenyatta University of Agriculture &Technology
JNNSM	Jawaharlal Nehru National Solar Mission
KCAL	Kilo Calories
KEBS	Kenya Bureau of Standards
KEREA	Kenya Renewable Energy Association
KM	KEBS mark of Quality
KNBS	Kenya National Bureau of Statistics
KTCO2	Kilotonnes Carbon Dioxide
KTDA	Kenya Tea Development Agency
KW	Kilowatt
KWH	Kilowatt-Hour
MAG	Magazines
MEDDESIRE	Mediterranean Development of Support Schemes for Solar Initiatives and Renewable Energies
MENA	Middle East and North Africa
MLE	Maximum Likelihood Estimation
MNRE	Ministry of New and Renewable Energy
M.Techs	Masters of Technology
MW	Megawatts
NIC'S	Newly Industrialized Countries
NISE	National Initiative for Solar Energy
NP	Newspapers
OECD	Organization for Economic Co-Operation and Development
PhD	Doctor of Philosophy
PLR	Penalized Logistic Regression

PMLE	Penalized Maximum Likelihood Estimates
PNPCs	Perceived New Product Characteristics
PPP	Public Private Partnerships
PPR	Public Presentations
PRC	Peoples Republic of China
PV	Photo Voltaic
RE	Renewable Energy
RET	Renewable Energy Technology
SBS	Subsidies
SDGs	Sustainable Development Goals
SEGS	Solar Energy Generating Systems
SEIA	Solar Energy Industries Association
SHS	Solar Homes Systems
SMS	Short Message Service
SPPU	Savitribai Phule Pune University
TV	Television
UK	United Kingdom
UN	United Nations
UNDP	United Nations Development Programme
UNEP	United Nations Environmental Programme
UNIDO	United Nations Development Programme
US	United States of America
USA	United States of America
USD	USA Dolar
VETIs	Vocational Education Training Institutes
VC	Venture Capital
WEF	World Economic Forum.
Wts	Watts
WRST	World Renewable Spiritual Trust
WSP	Workshops

ABSTRACT

This study focused on the Kenyan tea industry which has been faced with the challenge of identifying a sustainable source of process heat energy. Sixty five of the factories managed by Kenya Tea Development Agency (KTDA) use fuel wood and minimal fuel oil for process heat generation. Both these sources are not sustainable due to their high costs, depletion and negative impact on the environment. This challenge threatens future survival of the industry, Kenya foreign exchange earnings and the livelihood of the 600,000 small scale tea farmers. One source of heat energy that has been recommended for the industry is the concentrated solar power technology (CSPT). This is a renewable energy source that can be used to replace about thirty per cent of the wood and oil sources. It would be cheaper, more environmental friendly and would greatly enhance the survival of the tea industry and by extension the livelihood of the farmers. However, despite its apparent benefits and promise, by 2013 the CSPT technology had not been adopted by any of the 66 tea companies under KTDA. The general objective of this study was to investigate the determinants of the likelihood for the adoption of Concentrated Solar Power technologies by the Kenyan tea factories run by KTDA. Specifically the study investigated the effect of the variables CSPT attributes, CSPT awareness, organization complexity, access to finance and standardization on the likelihood of the adoption of CSPT by tea factories managed by KTDA. The target population was all the sixty six factories managed by KTDA while the respondents were factory unit managers of the 66 tea factories.. The study was a cross-sectional survey taking a quantitative approach with descriptive and inferential statistical outcomes. This adoption study was anchored on the diffusion of Innovations theory. Other theories applied were UNESCO awareness raising model, the World Bank's commercial financial instruments for renewable energy model, and the ISO guide on standardization. Data collection was done using a structured questionnaire which was piloted in four private tea factories to test its reliability and validity. The questionnaires were delivered and picked by the researcher and a 100% response rate was attained. A binary logistic regression model was used to analyse data, making use of IBM SPSS statistics version 23 and STATITICA version12 software to generate statistics that enabled hypothesis testing. Most of the managers (89%) were not aware of the concentrated solar power technology but all had the education level necessary for CSPT training. On testing the hypotheses, CSPT attributes, CSPT awareness, organizational technical capacity, and CSPT standardization were found to be statistically significant with a likelihood to influence the adoption of CSPT. CSPT attributes were found to be the most likely variable to influence adoption of CSPT by the tea factories, followed by CSPT awareness, CSPT standardization and organizational technical capacity respectively. Access to finance was not found to have a significant likelihood of influencing the adoption of CSPT. In conclusion there is minimal adoption of CSPT among tea factories managed by KTDA mainly due to lack of awareness of its existence and its benefits over wood and oil sources of heat energy. The managers and technicians in the factories have basic education but need specialized training on CSPT. Standards on the quality of the technology and its installation were also found to be key in minimizing uncertainty among the potential users and therefore enhance chances of adoption. The researcher recommends massive awareness creation campaigns on CSPT particularly through exhibitions, electronic publications, workshops, newspapers and brochures. Training courses in-house or abroad should be arranged for technical staff to enable them for CSPT adoption. There is also need to ensure CSPT products and the service providers are ascertained as to their adherence to quality standards and practices.

CHAPTER ONE
INTRODUCTION

1.1 Background of the Study

The Kenyan tea industry is faced with the challenge of identifying a sustainable source of process heat energy (Rawlins & Ashcroft, 2013). Sixty five (65) of the 66 factories run by Kenya Tea Development Agency (KTDA) use fuel wood and once in a while use fuel oil (Kamau, Kiplagat & Mwenda, 2015). Both these sources are not sustainable due to their high costs, depletion and negative impact on the environment. This challenge threatens future survival of the industry and the livelihood of the 600,000 small scale tea farmers whose 80% income is from tea. The industry is therefore in search of more sustainable sources of heat energy. One of the heat energy sources recommended for the industry is concentrated solar technology. The industry and the energy challenge it is facing is discussed in the following sections.

1.1.1 The Tea Industry

Tea is currently grown in 35 countries in the world (Forum for the Future, 2015). The tea industry is a key employer and generator of foreign exchange in the world, and more so in the developing countries. There are several classes of people that are dependent on tea for their livelihood. They start with tea farmers and tea pickers who get over 80% of their incomes from tea. Others are traders and dealers engaged in the tea supply chain worldwide, and lastly are the consumers who every day look up for a cup of tea to energize their day. The industry, therefore, has tremendous impact on many people's lives in the world.

China is the biggest tea producer, followed by India, then Kenya and Sri Lanka, in that order (Gunathilaka & Tularan, 2016). China contributes 28% of world tea production, India 25%, Kenya 9% and Sri Lanka at 8.5%. Other notable tea producing countries are Malawi, Rwanda, Tanzania and Uganda, while minor producers include Nepal, Peru, Papua New Guinea, Zimbabwe, Turkey, Vietnam, Indonesia, Argentina, and Bangladesh. The global market for tea was estimated to be around USD 15.4 billion in 2013 in terms of production value and USD 40.7 billion in terms of retail value. Beyond economic gains for the producers, tea productions also deliver other important ecosystem services such as carbon prevention, soil fertility protection and water conservation. Indeed, the survival and well-being of many people in the world rely on tea as an antioxidant.

The tea supply chain is dominated by multinational companies (Groosman, 2011). About 80% of tea production in the world is sold by multinational organizations. Two major organizations in the trade are Unilever and Tata Tea. Unilever controls about 12% of the world production, while Tata has a 4% market share. Other multinationals in the tea industry are Associated British Foods, Van Rees and James Finlay. Overall, only seven organizations control over 85% of tea produced and consumed worldwide (Agritrade, 2012). Most of these organizations are multinational companies with operations covering the entire tea supply chain. They grow tea in plantations, are packers and distributors of tea in different parts of the world. Tea value addition is higher after primary production in the farms. Blending is one of the operations that improves on tea value. Other such operations are packing and branding. These later stages in the tea supply chain actually take up to 80% of tea shelve price (Agritrade, 2012). These high value operations are mostly done in the multinationals facilities in their home countries in Europe and other developed countries.

According to Food and Agriculture Organization (FAO) (2015), the margin between processed packed tea prices and primary auction prices has been widening, implying that the tea growers are not benefiting from the rising consumer market for processed tea products. The main tea importers are seven countries. These are the Russian Federation, the United Kingdom, Pakistan, United States of America, Iraq, Egypt and United Arab Emirates.

Energy is a key input in tea processing (Kamau et al, 2015). Heat energy is used to remove moisture from the green tea leafs. It is also used to further dry the fermented teas. On the other hand electrical energy is used in almost all stages of tea processing operations. Overall energy costs will comprise about thirty percent (30%) of the total costs of tea processing (Baruah, Punja & Rao, 2012). Several activities require different types of energy of varying intensity in tea processing. The key operations are withering, fermentation, drying, sifting and packing. These operations make use of electrical, heat and human energy. Over 80% of the energy requirement in tea processing is heat energy used to remove moisture from tea leaves during withering and also drying (Baruah et al, 2012). To make a kilogram of ready tea requires 3.5-6 kWh of heat energy, 0.21 - 0.5 kWh of electrical energy plus 0.11 kWh of manpower. Further it requires about 32 kilo calories (kcal) of energy for drying green tea leaves that will yield a teaspoon of tea. In the process approximately 17 grams of carbon dioxide is emitted.

Tea in Kenya has been the country’s leading foreign exchange earner in the last ten years, attaining export earnings of about Kshs 105 billion in 2013, an improvement over the Kshs 33 billion earnings in 2003 (Kenya National Bureau of Statistics (KNBS), 2015).

In 2014 tea exports generated 24% of Kenya's foreign exchange earnings and the sector employed 120,000 workers in addition to the 600,000 small holders who grow tea. Tea production accounts for over 11 per cent of agriculture's share of Kenya's Gross Domestic Product (GDP). Tea is also a catalyst for rural development as it is grown in 15 counties across Kenya. The industry directly and indirectly is a source of livelihood for about five million people in Kenya, making it one of the corner stones in economic well-being for Kenyans. The Kenyan tea sub-sector is one of the industries in Kenya with a significant need for process heat. Its energy requirement is in the temperature range of 60-80^{o}C (Rawlins & Ashcroft, 2013). The Kenya Tea Development Agency (KTDA) is mandated to manage 55 Kenyan tea companies owned by small scale farmers. In 2011, thirty six (36) of the companies run by KTDA complained of rising fuel costs as a key threat to their organizations (Rawlins & Ashcroft, 2013). Almost all of the factories were using fuel wood as their basic source of heat energy. However, wood supply was declining as trees and forests got depleted. Prices of wood were also rising. This scenario triggered plans by thirty four (34) of the companies to plan to plant their own trees. They identified eucalyptus trees as a viable tree to be grown in plantations on the factories land as a self-reliant and sustainable source of wood fuel. This was to be attained by the year 2015. This initiative was, however, faced by the challenge of inadequate land for sustainable wood production for the increasing demand of heat energy.

In the same period seventeen (17) factories were reported to be using fuel oil for heat generation. These factories complained of rising oil prices, and were reported to have decided to change from using fuel oil as their heat energy source (Rawlins & Ashcroft, 2013). Further, these factories were reported to have used 3.6 million litres of oil in 2011, which resulted in carbon dioxide (CO_2) emissions of about 14 kilo tonnes carbon dioxide

($ktCO_2$). The tea factories were reported to be the target of the sole supplier of small-scale CSPT technology in Kenya, and the study by Carbon Trust suggested 1.1 million litres (30%) of their fuel demand could be replaced and 4.3 $ktCO_2$ carbon emissions averted by use of CSPT.

1.1.2 Solar Energy Technology

Technological improvements, accompanied by a surging interest in use of green energy technologies, have made solar energy technologies a prime focus area for renewable energy development (Association for Small Business & Entrepreneurship (ASBE), 2009). The escalation of global prices of sources of heat energy coupled with an emerging strong interest in use of green and renewable technologies has instigated great focus on and growth in solar energy technologies. The cost to produce solar energy has decreased by 70-80% in recent years, (IISD, 2014). Although these improvements in cost are significant, some barriers have been reported to hinder the solar technologies from attaining extensive adoption. The barriers cited to hinder market penetration of the solar technologies include lack of regulations on new renewable energy technologies, poor leadership, financing risks, and high cost of financing.

There are two broad solar technology types: solar photovoltaic and solar thermal technologies. Solar photovoltaic (PV) is a technology through which sun energy is transformed to electrical energy (Bhutta, 2012). PV is used for domestic, commercial and industrial purposes. In homes its used for lighting and for water heating, for example using solar home systems (SHS) of about 2000 watts. In industries it is used for lighting and also heating with solar power plants in the range of 10 kilowatts (kW) to 20 megawatts (MW).

On the other hand, solar thermal technology changes sun energy into heat energy. It is used in commercial and industrial enterprises for water heating and steam generation for various operations. Milk pasteurization and condensation is one common application of thermal energy. Others are drying in tea factories and tanning in leather industries (Bhutta, 2012).

Solar heat technologies used in industrial processing are broadly classified into three categories. These are solar air collectors, solar water systems, and solar concentrators (IEA-ETSAP & IRENA, 2015). Solar air collectors are mostly used in the food industries for drying and moisture reduction to avert food spoilage. Solar water systems are commonly found in homes mostly used to heat water for bathing, swimming pools and cooking. Others are installed on light industry's rooftops for water heating and steam generation of up to about 125^{o}C. Examples of these solar water systems are flat-plate collectors (FPC) and evacuated tube collectors (ETC). Solar concentrators use mirrors to concentrate sun rays to generate heat. There are various types of concentrators such as the parabolic dish, the linear parabolic trough and the linear Fresnel. The concentrators can produce process heat in industries, as well as provide on-grid or off-grid electricity (Rawlins & Ashcroft, 2013).

Even though solar heat technologies have exhibited a strong technical potential, and high promise for economic benefits for industry processes, their adoption has been very low (IEA-ETSAP & IRENA, 2015). To achieve higher market penetration, some new initiatives have been recommended. They include creating greater awareness of the existence of, and benefits of, using solar heating technologies among industries and small and medium enterprises (SMEs). Others are providing financing especially for covering the initial acquisition costs, and supporting use of solar heat energy technologies as an alternative to subsidizing use of fossil fuels by industries.

1.1.3 Concentrated Solar Power Technology (CSPT)

Concentrated Solar Power Technology (CSPT) facilities use mirrors to focus sunlight on a receiver, which receives, transforms and transfers the sun energy to a heat transfer fluid which in-turn supplies heat direct for application in a process (IEA-ETSAP & IRENA 2015). Large CSPT facilities are fitted with a heat storage system used for storage and supply of heat or electricity at night or when weather is unfavourable. Four CSPT technologies are commonly used across the world. These are Parabolic Trough technology, Fresnel Reflector technology, Solar Tower technology and Solar Dish technology.

Modern CSPT originates from the times of Solar Energy Generating Systems (SEGS) constituted in the Mojave desert in California in the 1980s (Hu and Wu, 2013). The US dithered in supporting CSPT systems owing to declining fossil fuel prices. However, around 2006 the market re-emerged in Spain and the United States. This was mainly triggered by government initiatives such as feed-in tariffs in Spain, and policies requiring industries to use some share of power from renewable energy technologies. These CSPT installations were used mainly to fuel plants in remote facilities such as mines and cement factories. They were also applied in homes for cooling and heating, and for producing steam for oil recovery in the United State.

By the year 2010 global stock of CSPTs installed was about 1 GW capacity, while Projects in development stage or under construction in various countries (including China, India, Morocco, Spain and the United States) were expected to total 15 GW (OECD/IEA, 2010). By 2013 attention was shifting from European and US projects to those in other emerging countries. China has lead the way, by first announcing in 2011 a target of 1GW of CSPT installation. This target was raised in 2012 to 3GW for CSPT installed by 2015. Further, the country's 12^{th} five-year plan highly emphasized the great promise of CSPT, and as a result further raised the installation target to 10GW of commercial scale activity by 2020. The country's target of a 3GW CSPT installed capacity by 2015 would exceed the entire world cumulative installation of 2.5GW. This would effectively make China the world's CSPT leader, leading in energy cost reductions, and increased rate of diffusion of CSPT in the world as a key substitute of nuclear and fossil sources of power.

Several newly industrializing countries have moved fast to embrace the CSPT. India has made great efforts for a strong CSPT sector, utilizing the country's good solar insolation (Hu and Wu, 2013). Within the Jawaharlal Nehru National Solar Mission (JNNSM) framework, India is expected to produce 10GW of grid-connected solar power from CSPT by 2020. By 2013 India was the global leader in CSPT industrial applications having 70 installed systems out of the approximately 100 installed worldwide (Rawlins & Ashcroft, 2013). According to a study conducted by UNDP, about 50 of the 70 CSPT systems were being used for steam generation for very high volume cooking in religious institutions. The technology was also being applied in other industries including dairies, bakeries, and laundries.

South Africa has also emerged as a major CSPT player. The country's potential of CSPT projects has been estimated at about 40GW by Eskom, the principal electricity generator in that country. The country has a big project targeting to build a 5GW solar park in the Northern Cape. The country has strategized for a 100-fold expansion in CSPT installations in the next decade and a half, reaching 100 GW by 2025 (Hu and Wu, 2013). Other players in CSPTs development are in the Middle East and North Africa (MENA) region. Saudi Arabia has committed herself in major CSPT projects for up to 25GW, which are to be launched over the 2013 to 2030 period. The Middle Eastern and Gulf states have also been making moves in adoption of CSPT. They are doing so in an effort to complement their oil resource and also minimize dependence on oil. Saudi Arabia has announced a massive 25 GW CSPTs installation goal by year 2030, and Qatar is targeting 1.8 GW of CSPT capacity by 2020. In a study on renewable energy potential in the Middle East/North Africa region, by the German Aerospace Center, it was reported that by the year 2050, CSPT technologies will cater for about half of the region's electrical requirements, with a total installed capacity of 390 GW (OECD/IEA, 2010). Reports from Japan indicate that several Japanese districts are commissioning concentrated solar thermal (CST) plants to replace nuclear power plants.

According to literatures reviewed so far, there is no evidence of installed CSPT projects in Kenya. As per a report on a study conducted in Kenya in 2013 by Carbon Trust found there were two dealers in small-scale concentrated solar energy systems by 2013 (one specializing in concentrated solar thermal systems, and another one specializing on concentrated PV) in Kenya. However there was no evidence of any installed CSPT systems for either industrial process heat generation or lighting. (Rawlins & Ashcroft, 2013). The sole dealer of thermal CSPT systems was reported not to have been aware of any installed CSPT system in Kenya and claimed to have put in a lot of effort trying to gain acceptance of CSPT for industrial applications, with no success.

Considering the Kenya solar energy resource estimated at 4 to 6 kWh per square meter per day of solar insolation, the CSPT has been cited as a viable and sustainable source of heat energy for the country. A prototype parabolic trough solar concentrator for steam production developed at Jomo Kenyatta University of Agriculture and Technology

(JKUAT) generated a maximum temperature of steam of 248.3^{o}C while average temperature of steam produced was 150^{o}C (Kawira et al., 2012). These results obtained show that production of power using the sun flux is a viable undertaking in Kenya. Moving away from wood fuel and fuel oil to CSPT in industries could reduce carbon emissions and deforestation.

The study conducted in Kenya in 2013 by Carbon Trust expressed the viability of CSPT in Kenya (Rawlins & Ashcroft, 2013). This study particularly singled out the tea industry as a high potential beneficiary of CSPT. It that found the tea factories could replace 30% of their energy requirement by taking up CSPT. The study farther suggested the possibility of Kenya deploying many and varied CSPT systems across the country's industrial sectors. Various industries were cited that would potentially benefit from application of CSPT. These were salt processing industry, food and beverages industry, dairy industry, and pharmaceutical and cosmetics industries. Others were the textile industry, commercial laundries, and hotel and catering establishments. Another potential area of application of CSPT for industrial heat in Kenya is in cooling using absorption chillers, which is required in the cut flower sub-sector, in dairies and fish processing industries.

Energy is cited as one of the infrastructural enablers of the three "pillars" of Kenya Vision 2030 (GOK, 2007). The vision targeted more use of renewable energy sources to reduce over-reliance on hydroelectricity and by extension the frequency of power outages. The adoption of CSPT by the tea factories fits well in this desired vision. Further it is an initiative fitting the UN blue print Energy4ALL by 2030, in which one key strategy is doubling of contribution of renewable energy in the energy matrix by 2030 (IISD, 2014). Adoption of CSPT would also leverage the country on the path to attaining the recently formulated sustainable development goals (SDGs). By securing the tea industry it would be an effort in reduction of poverty by providing sustainable jobs in accordance to SDG number one (UN, 2017). It would also be in line with SDG number two which emphasizes promotion of sustainable agriculture and SDG number eight which promotes sustainable economic growth, employment and decent work for all. Finally, adoption of CSPT will be in the right direction of combating climate change and its impacts as stipulated in SDG number thirteen.

1.1.4 Adoption of Technology Innovations

Many authors have defined or described technology innovation's adoption. One of the earliest definitions of technology adoption was contributed by Rogers in his book, Diffusion of Innovations. He defined adoption as a decision to make full use of an innovation as the best course of action available (Rogers, 2003). A similar perspective was given in a report of a study by UNEP in 2012 on Overcoming Barriers to the Transfer and Diffusion of Climate Technologies in which adoption was described as a process by which a technology is selected for use by an individual, an organization or a society (Boldt et al, 2012). Thus, technology adoption comprises a process by which a new technology is taken up or installed by an individual, institution, company, or any other entity.

Aggregate adoption is referred to as technology diffusion. Technology diffusion refers to a process through which a new innovation spreads in a society, industry, or country. The innovation is gradually adopted by more and more members of the society, industry, or country (Shoeb, 2014). At any one time it is measured by the proportion of the potential users who have actually adopted the new innovation. Diffusion is, therefore, aggregate adoption. It is the aggregate process of product penetration. The extent to which innovations and new technologies contribute to economic growth and welfare in an industry or country is highly determined by the rate of diffusion of the innovations and technologies. According to Everett M. Rogers (Rogers, 2003) adoption takes place at the end of the innovation decision process. This is the process through which an individual, or any other decision making unit, gathers knowledge of an innovation, forms an attitude towards the innovation, makes a decision to adopt or reject the innovation, implements the new idea and finally confirm of the decision. The innovation decision process stages are briefly discussed next.

The first stage is knowledge stage. Adoption of a new innovation usually starts with seeking for knowledge on the innovation. It's difficult for one to commit to an innovation before knowing about the innovation. The potential adopter needs to know of the existence of the innovation, how the innovation works and how best to use the innovation (Shoeb, 2014). This awareness of the innovation is mostly gotten through the media (television, newspaper, radio), peers, colleagues or mentors. Next is the persuasion stage. Having gotten knowledge of an innovation, a person becomes more conscious of the benefits of the technology. Such a person develops interest in the technology and seeks farther information on the technology, for example its cost, current users views, its features, and how it works. It is at this stage that a person start considering self as a potential adopter of a technology and earnest consideration of whether to adopt the technology or not begins.

The third stage is decision stage. The choice to adopt or not adopt a technology is arrived at in this stage. The stage often involves comparing the benefits and costs of the innovation, generally trading-off advantages and disadvantages. From the trade-off analysis the decision to accept or reject a technology is made (Rogers, 2003). The decision stage is followed by implementation stage. The implementation stage involves putting the technology into use. During the stage the technology is assessed on whether it meets the adopters' expectations and more guidance on the technology is sought to maximize on the utility of the technology. The final stage is confirmation stage. This stage is attained when an innovation is integrated and made use of fully by an adopter. At this juncture the adopter wants to affirm that the right innovation decision was made. Nevertheless, sometimes the original decision to adopt a technology may be rescinded (reversal) if there is dissonance about the innovation adoption decision. In this case the adopter decides to stop the usage of the technology.

1.1.5 Factors Influencing Technology Adoption

Within the stages described above several factors could arise that are likely to affect the adoption of an innovation by the potential adopter, thereby influencing a positive or negative adoption decision. First Rogers identified awareness of an innovation as key to innovation adoption (Sahin, 2006). Awareness of the features, advantages and disadvantages of a new technology helps to reduce uncertainty of adopting the technology.

Rogers also identified five characteristics of innovations that may be used to minimize uncertainty in an innovation, which in-turn improves the likelihood of adoption. These were the innovation's relative advantage, its compatibility with technology in use, its complexity, its trialbility, and observability. Relative advantage refers to the extent to which an innovation is seen as being better than the technology currently in use (Sahin, 2006). Compatibility refers to the extent to which an innovation is seen to abide with the existing values, past experiences, and the requirements of the potential adopters (Shoeb, 2014; Sahin, 2006). Complexity, on the other hand, is about the extent to which an innovation is considered as relatively difficult to comprehend or use. Rogers noted that complexity and adoption have an inverse relationship. Trialbility is the degree to which an innovation may be tried before or tested before adoption (Shoeb, 2014; Sahin, 2006). The more a new technology is triable, the more likely it is to be adopted. Finally, Rogers explained observability as the extent to which the outcomes of use of an innovation are visibly evident to others. He explained that observability is strongly promoted by role modelling and peer observations, which in-turn enhance chances of innovation adoption.

Rogers later identified organization structure characteristics as determinants of technology innovations adoption. Specific characteristics identified were centralization, organization complexity, formalization, interconnectedness and Organizational slack (Rogers, 2003). Centralization is considered as the extent to which power and control in an organization are concentrated in the hands of a few individuals. It has been negatively associated with innovativeness. Complexity refers to the extent to which members of the organization are perceived to possess a relatively high level of knowledge, skills and expertise, which in-turn is measured in terms of members' spectrum of occupational specialties and their levels of professionalism (Rogers, 2003). Complexity is said to enhance organizational members' potential for conception and generation of innovations. Formalization is about the extent to which the organization emphasizes adherence to rules and procedures in the various functions and roles of the members. Formalization is said to hinder conception of innovations by members of the organization, but may encourage implementation of innovations.

Interconnectedness refers to the extent to which the various units of an organization are linked by interpersonal networks (Rogers, 2003). New ideas easily permeate through various sections and groups of an organization if the organization has considerable interconnectedness, and interconnectedness is said to have a positive relationship with organizational innovativeness. Finally, Organizational slack refers to the extent to which there are uncommitted resources in an organization. The more uncommitted resources available the more innovative an organization is likely to be.

Other factors likely to determine adoption of innovations have been identified. Access to finance has been cited in many studies as a major determinant of technology adoption decisions (Silva, 2014; Topo, Moretta, Glorioso & Pansini, 2014; Hedeina, Pohlb, Mansorc & Genderen, 2015). Non availability of financial incentives, flexible funding mechanisms, high costs of capital and risks associated with new technologies have been highlighted as drawbacks to new technology adoption. Another factor cited to hinder adoption of new technologies is poor quality technologies. Technologies that fail due to poor quality cause market spoilage, creating negative attitudes in potential customers' minds, and thereby deter further adoption of the technology (IRENA, 2013).

In summary technology adoption refers to a decision by which a new technology is taken up by members of a society, industry or country. However a number of factors may influence the potential adopters in making the adoption decision. These include the potential adopters' awareness of the technology, attributes of the technology and availability of financial resources. Others are assurance of technology quality and in the case of organizations, the organization structure characteristics.

1.1.6 Technology Adoption and Business Growth

Ability to adopt new technologies has been in the past found to be vital for national economic growth (Comin & Hobijn, 2008). For instance, rapid economic growth of Japan after the second world war, and the Asian 'tigers' in the 1990s, has been attributed to their quick adoption of new technologies such as internet and innovative steelmaking processes. As with the case of nations, technological innovation has been associated with promotion of organization competitiveness, access to new markets, attainment of cost advantages and repositioning to go up the value chain (Han & Park, 2017; Kasim & Altinay, 2016; Gajavelli, 2018). Adoption of cutting edge technologies ahead of competing organizations is a mechanism used to quickly respond to changing environment and for attaining competitiveness. It is a pre-requisite for successful modern manufacturing organizations (Eeva et al, 2018). As organizations grow they need to enhance their innovative capabilities to survive and accelerate growth.

1.2 Statement of the Problem

The Kenya tea industry plays a big role in economic development of the country and contributes to rural industrialization. Tea export accounts for about 25% of Kenya's total agricultural export income of which 62% is contributed by the smallholder tea factories. There are sixty six smallholder tea factories in Kenya managed by KTDA that contribute 4% of the Kenyan economy GDP. Statistics indicate that over 600,000 households in Kenya rely on tea farming as their sole source of livelihood. It is farther estimated that about 10% (4,000,000) of the Kenya population indirectly rely on the tea sector as a source of income. These statistics point to the tea as a key commodity and foreign exchange earner in Kenya.

The annual returns to the farmers are estimated to be less than 10% of the proceeds per kilogram of processed tea. One of the key contributors of low returns to the farmer is the cost of energy. Cost of heat energy erodes the incomes of the small farmers, threatening the sustainability of tea farming in Kenya. If this trend continues, the scenario threatens achievement of the economic pillar of Kenya vision 2030, and SDG 1 on reduction of poverty. The factories are faced with the challenge of identifying a sustainable source of process heat energy. By 2013 thirty four (34) of the factories were reported to be using wood fuel to produce process heat, with the average tea factory using 20,000 cubic meters of firewood annually, which equals about 60,000 trees. The others were reported to be using fuel oil to generate process heat and were reported to have used 3.6 million litres of oil in 2011, which resulted in carbon dioxide emissions of approximately 14 ktCO2. Both the wood and oil sources are not sustainable due to their high costs, depletion of natural resources, their negative health effects and their negative impact on the environment. This challenge threatens future survival of the tea industry, Kenya foreign exchange earnings and the earnings and livelihood of the 600,000 small scale tea farmers, whose 80% income is from tea.

A source of heat energy that has been recommended by sustainable energy experts for the industry is the concentrated solar power technology (CSPT). It has been observed to replace 30% of factories thermal energy requirements. This source would be cheaper, more reliable, more environmental friendly and would cut on factory costs which in-turn would result in higher payouts to the farmers. These would secure survival of the Kenya tea industry and by extension the livelihood of the farmers. It would also give the country a nudge in the accomplishment of Sustainable Development Goals (SDGs) 1 and 2 that emphasize minimization of poverty and supporting people-centred rural development. The initiative would also be a promotion of access to sustainable and modern energy, as well as leverage on the fight to combat climate change and its impacts as envisaged in SDGs 7 and 13.

However, despite the apparent benefits and promise of CSPT, by 2013 the technology had not been adopted by any of the 66 tea factories under KTDA. Technology innovation adoption theories suggest a number of factors that are likely to influence adoption of new technologies. These are attributes of the innovation, awareness of the technology, access to finances by potential adopters, technical capacity of the adopting organization and existence of assuring standards of the innovation among other factors. This study sought to investigate the factors that are likely to influence the adoption of this solar innovation by the tea factories run by KTDA.

1.3 Research Objectives

This study was be guided by the following objectives.

1.3.1 General Objective

The general objective of this study was to investigate the determinants of the likelihood of the adoption of Concentrated Solar Power Technologies (CSPT) by Kenyan tea factories run by KTDA.

1.3.2 Specific Objectives

This study sought to achieve the following specific objectives:

i) To analyse the effect of CSPT attributes on likelihood of the adoption of CSPT by the KTDA run tea factories in Kenya.

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

iii) To assess the effect of organization complexity on the likelihood of the adoption of CSPT by the KTDA run tea factories in Kenya.

iv) To evaluate the effect of access to finance on the likelihood of the adoption of CSPT by the KTDA run tea factories in Kenya.

v) To assess the effect of CSPT standardization 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.

General Objective.

H_{06}: The independent variables (CSPT attributes, CSPT awareness, Organizational technical capacity, access to finance and CSPT standardization) 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_0$1: There is no significant relationship between CSPT attributes and likelihood of adoption of CSPT by the KTDA run tea factories in Kenya.

Objective Two

$H_0$2: There is no significant relationship between CSPT awareness and likelihood of adoption of CSPT by the KTDA run tea factories in Kenya.

Objective Three

$H_0$3: There is no significant relationship between organization complexity and likelihood of adoption of CSPT by the KTDA run tea factories in Kenya.

Objective Four

$H_0$4: There is no significant relationship between access to finance and likelihood of adoption of CSPT by the KTDA run tea factories in Kenya.

Objective Five

$H_0$5: There is no significant relationship between CSPT standardization and likelihood of adoption of CSPT technologies by the KTDA run tea factories in Kenya.

1.5 Significance of the Study

This study sought to give an insight into the factors that affect the adoption of CSPT technologies in the Kenya tea industry. Such insight would play a big role in informing the managements of the tea factories on adoption possibilities of the technology that may in turn help them in mitigation of ills emanating from conventional sources of energy such as fuel oil and fuel wood. The results of this study are likely to have significant impact on other stakeholders.

The factories that install CSPT factories based on the studies recommendations will attain some level of the much desired cost reduction through lower factory energy bills. This is likely to translate to higher profits for the factories and better returns for the shareholders. Beyond cost reduction CSPT provides an energy source available twenty four hours a day. This alleviates the current situation where the factories are faced by intermittent energy supply occasioned by regular power outages. The CSPT will also see a reduction of air pollution as CSPT replaces part of biomass and oil fuel sources. This will improve international acceptance of the factory products on account of environmental conservation and global warming control. Further use of the CSPT will mean less health hazard challenge for employees thereby improving workers health, motivation and ultimately productivity.

Beyond the tea sector, CSPT is a universal source of process heat that can be applied in other industries in Kenya with heat requirements of maximum range of about 400^0C. There are many such industries in Kenya such as the dairy industry, breweries and cement plants just to mention a few. Outcomes of this study will inform on approaches that enhance adoption of CSPT and might enlighten the stakeholders in these other industries to adopt this sustainable energy source. They will stand to gain the benefits of lower costs, less pollution, and the environment conservation claim.

The tea farmers are likely to enjoy several benefits if CSPT is widely adopted by the tea factories following the findings of this study. First it will improve the likelihood of the survival of the industry and therefore secure their income source and livelihood. Beyond this, the lower energy costs are likely to raise factory profits, which in-turn are likely to translate into higher tea payments and dividends for the farmers. Less use of biomass will help reduce deforestation, global warming and by extension improve regular and adequate rainfall for the tea farms. This is likely to raise tea production and expected returns for the farmer.

The study was also an attempt to bridge literature gap on diffusion of CSPT technology especially in developing countries. Being a relatively new technology, hardly any comprehensive literature has been put together on its status and potential in Kenya and other developing countries. The study also brings together important facts, experiences and insights about the promotion of this technology which will aid policy makers. Government, development partners, and other policy makers will get important information that might help improve policy formulations and implementations, in line with already set out blueprints such as Kenya Vision 2030 and the UN Energy4ALL initiative. Kenya vision 2030 emphasizes exploitation of renewable sources of energy to power economic and industrial growth in the country (GOK, 2007). Further, realization of adoption of CSPT by tea factories as recommended by this study, will help the country make a move in the right direction in attaining at least four of the global SDGs. It would help the country's efforts in reduction of poverty and promote rural development in line with SDG 1 and SDG 2. It will also help in the promotion of use of sustainable and modern energy as well as minimize the impact of climate change, in line with SDG 7 and SDG 13.

The study was an additional building block in CSPT and renewable energy literature for the benefit of academia and researchers at large. It provides a platform for testing applicability of adoption theories, and develops leads for future research in its recommendations.

1.6 Delimitations of the Study

This study focused on diffusion of CSPT technologies in the Kenyan tea industry but only in factories operated under KTDA. This was because these tea factories had explicitly expressed their interest to change their primary fuel source (Rawlins & Ashcroft, 2013). The researcher, therefore, considered them to be in more dire need for interventions on the energy challenge than the private operators. Further, due to their public nature the researcher expected to access information more easily owing to the less bureaucratic and secrecy issues. The respondents were factory unit managers. This is because they were considered pivotal in decision making of past and future energy source choices of the factories. They, therefore, were more likely to provide the necessary information for the study than any other calibre in the factories.

1.7 Limitations of the Study

The 66 target factories of the study were spread out in 15 counties in Kenya. This is a vast coverage for the study. The factories were also generally located in the highlands, way off main transport routes. These factors caused logistical and financial challenges.

Beyond logistical challenges, the study was faced by data analysis limitations. The dependent variable was the adoption of CSPT among tea factories run by KTDA in Kenya. Adoption is a dichotomous concept, and results of observations of dichotomous values do not have a linear relationship, and therefore inferential analysis of such data cannot be subjected to linear regression. An analysis approach without the linearity assumptions had to be identified. For this purpose logistic regression was selected for this study.

A further challenge of the study was that standard logistic regression was hard to apply in the study. This was because the model assumes, among other things, a large data set and a fair distribution of the two dichotomous categories. Adoption of CSPT by the tea factories study had a population of 66 (considerably small population and data set) and produced a rare data set. Rare event data consists of binary dependent variables with thousands of times fewer *ones* (desired event) than *zeros* (undesired event) (Allison, 2012). Standard logistic regression arrives at maximum likelihood estimates (MLE) of the relationship between the dependent variable and the indicator variables. However, MLE algorithms analysis breaks down when rare event data is run. Alternative logistic regression approach circumventing the above problem had to be found, and penalized logistic regression was embraced.

Penalized logistic regression (PLR) is a variation of logistic regression developed to take care of complications that arise when analysing complex data using standard logistic regression and maximum likelihood estimation. It yields penalized maximum likelihood estimates (PMLE) using algorithms such as Ridge, Lasso and Firth. Firth penalized logistic regression model was selected for this study.

1.8 Assumptions of the Study

Assumptions are statements of what a researcher believe to be facts but may not verify (Best & Khan, 2011). The first assumption of this study was that all the 66 tea factories managed by KTDA are similar in their energy requirements and share the urge to find a sustainable source of process heat. Secondly the researcher assumed the factory unit managers capability to accurately review and project their factories process heat scenarios in comparison with global benchmarks.

1.9 Definition of Terms

Concentrated Solar Power Technology

Concentrated solar power technology (CSPT) refers to equipment that use mirrors to concentrate the energy from the sun to generate heat (thermal energy) (SEIA, 2014). CSPT uses the solar resource to produce electricity or heat while generating very low levels of greenhouse-gas emissions (IEA, 2010). Currently there are four main well established CSP technologies, which are classified according to the way they focus the sun's rays and the technology utilised for the reception of the solar energy. These technologies are Linear Fresnel Reflectors, Solar towers, Parabolic Troughs and Parabolic Dishes.

CSPT Awareness

Awareness creation is a means of making a group of people aware of something (ESTIF, 2012). In new products adoption schemes awareness is aimed to reduce uncertainty potential adopters may have in new technology innovations. Potential adopters are made aware of advantages and disadvantages of new innovations to prepare them for the consequences of adoption of the innovations (Sahin, 2006).

Technology Adoption

This is a process by which a technology is selected for use by an individual, an organization or a society (Boldt, J.et al, 2012). It has also been defined as the stage of selecting a technology for use by an individual or an organization (Sharma & Mishra, 2014). It is a process involving five stages. These are knowledge, persuasion, decision, implementation and confirmation stages. In this study adoption of CSPT technology refers to whether a tea factory has installed a CSPT technology or not.

Access to Finance

This refers to ability for raising or providing money or capital for realizing a project or continuing an activity (IPCC, 2011). This could be from capital sources, credit or grants.

Organization Complexity

Organization complexity refers to the extent to which members of the organization are perceived to possess a relatively high level of knowledge, skills and expertise, which in-turn is measured in terms of members' spectrum of occupational specialties and their levels of professionalism (Rogers, 2003). Complexity is said to enhance organizational members' potential for conception and generation of innovations.

CSPT Standardization

Standardization involves developing and providing standards, and the dissemination of information on various standards to stakeholders (ISO, 2013). The work of the standards is to endorse that a product or service offered is fit for a said purpose, is safe and has value (IRENA, 2013). An important aspect of this protection is the assurance that the product or service delivers as promised, performs as per specifications, and is reliable, durable and safe. CSPT Standardization variable in this study will be an investigation of the existence of such standardization in the CSPT market.

CHAPTER TWO
LITERATURE REVIEW

2.1 Introduction

This chapter reviews literature of various scholars on adoption of new solar technologies (particularly CSPT technologies) and its determinants. It starts with a discussion of the independent variable, adoption of CSPT, followed by a review of theoretical and empirical literatures. Then the conceptual and operational frameworks for this study are presented.

2.2 CSPT Adoption

As discussed in chapter one, CSPT technology has been applied for various purposes in the past especially in America and Spain. Other countries have engaged in programmes to benefit from this technology too. Of importance for this study is the application of the technology in industrial processes as opposed to catering for energy needs of remote locations as was common for most CSPT applications in the past. Evidence exist of such initiatives in the last decade and several of them are discussed in this section.

One case is the UNDP/GEF project carried out in India (South) on energy conservation and energy efficiency of tea factories. The project was implemented in the 2008-2011 with the aim of reducing energy consumption for tea processing factories in south India and thereby minimizing greenhouse gas (GHG) emissions (Ocampo & Maithel, 2012). A key aim of the project was to come up with replicable strategies for sustainable energy innovations in tea production in south India. Specific strategies laid out were awareness creation on renewable technologies relevant to the tea industry and the profitability emanating from their adoption. Other strategies were minimization of financial barriers that hinder investment in renewable energy technologies, adoption of renewable energy equipment, and knowledge sharing and replication.

On completion the project had created awareness among all 266 factories in the region on renewable energy technologies and successfully introduced seven new renewable energy technologies adopted by 114 factories (Ocampo & Maithel, 2012). These investments had the impact of reducing carbon emissions by 277,255 tons annually among the factories.

A second project is UNDP/GEF project in India promoting Solar Concentrator Based Process Heat Applications, which was implemented in the 2012-2017 period. This was a national project by the Ministry of New and Renewable Energy India (MNRE) in conjunction with GEF and UNDP (Akker & Aggarwal, 2015). The project aimed to strengthen awareness for promotion of use of concentrated solar heat (CSH) systems, to strengthen capabilities for promotion of use of (CSH) systems, remove market and financial barriers promotion of use of (CSH) systems, strengthen technical capabilities among industry stakeholders by conducting training programs (for manufacturers, installers and CSH users), supporting demonstration projects, and addressing financial barriers. The project is ongoing but by 2016, 210 establishments were applying CSH systems and were already attaining 6,200 tonnes of carbon emissions reduction annually. It is anticipated to accomplish carbon savings of 32,900 tonnes and save 3.15 million litres of fuel oil annually (UNDP, 2016).

In Malaysia UNIDO has initiated a project to minimize GHG Emissions through EE and use of solar heat systems. This is a 60 months project whose key components include awareness raising and capacity building for solar thermal utilization in targeted industrial sectors. This would involve among other things improvement of skills and competences of technicians, consultants and industry staff in solar heat technology. Another component is the demonstrations and case studies of thermal energy utilization. The project involves 40 factories. Though results of the project have not yet been documented, 10 of the forty factories are expected to implement solar thermal projects.

An electric CSP power generation project has been implemented at Holaniku, Hawaii, USA. It is a parabolic trough which was commissioned in 2009 with a temperature range of 74-95^{0}C (Garud, 2014). The project is to attain carbon emissions reduction of 31ktCO_2 over its life time. A similar project is installed at Holcim, Mexico. This is a CSP cement cooling system started in 2011 with a temperature range of 74-95^{0}C, and is expected to save 3.45ktCO_2 over its life. At Watow, Germany there is a CSP process heat generation system for a fish farm. It was initiated in 2007 with a maximum heat generation of 250^{0}C. Another CSP process heat system has been adopted at Chitale Dairy, India. It was commissioned in 2009 and has a maximum temperature range of 152^{0}C. It has carbon emissions savings potential of 130CO_2 per annum and is able to replace 40,000 – 60,000 litres of fuel oil per annum.

The above are just but a few of CSPTs adopted for industrial application. Several of them will be mentioned in the following section when discussing individual determinants of CSPT adoption.

2.3 Theoretical Literature Review

This study is rooted in the concept of adoption of novel innovations. However, Technology adoption is rarely discussed in most literatures without a mention of technology diffusion. As explained in chapter one the two concepts are related and most theories reviewed expound on them together. Many technology adoption theories have been put forward beginning around 1900. The first well documented contribution is that Gabriel Tarde of around 1903. He was a French sociologist and is said to be the originator of the S-shaped diffusion curve. (Shoeb A., 2014). Subsequent contributions were by Bryce Ryan and Neal Gross around 1940, but most outstanding in diffusion literature is Everett M. Rogers' model of 1962. In this section theories in respect to this concept will be reviewed with a view to clarifying the variables and relationships for this study.

2.3.1 Diffusion of Innovation Model

Everett M. Rogers is largely famous for inventing the diffusion of innovation theory which he developed after his research on how farmers take up new agricultural innovations (Shoeb, 2014). Rogers explained that diffusion is a social process in which adoption of a technology starts slowly, followed by rapid adoption and ending with slow adoption as product matures and new innovations emerge. The theory identified four components of the diffusion process which were the innovation, communication channels, a time period, and a social system.

As cited in (Sahin, 2006), Rogers defined innovation as an idea, process, or practice that is considered as novel by individuals or groups or organizations. He claimed that uncertainty about new innovations is a major hindrance to the adoption of innovations. This is because the consequences of using an innovation may create uncertainty. Consequences refer to new experiences that an individual or a social system is exposed to as a result of adopting an innovation. Therefore, to minimize this uncertainty before adoption of a new technology, individuals or organizations should be made aware of the advantages and disadvantages of the new technology so as to prepare them for its consequences. He also identified five characteristics of new innovations that are useful in minimizing uncertainty about an innovation thereby increasing the chances of its adoption. These were relative advantage of the innovation, compatibility with what is in use, its complexity, whether it is trialable, and observability. Relative advantage is the extent to which a new technology is seen as being better than the innovation it precedes (Sahin, 2006). Cost advantage, profitability and social status of innovations are examples of aspects of relative advantage.

Compatibility of a new technology refers to the extent to which it is perceived to be conforming to the current values, experiences from the past, and the needs of a potential adopter (Shoeb, 2014; Sahin, 2006). When a technology is seen to conform to the needs of an individual, its likely to reduce uncertainty which will in-turn raise the rate of adoption of an innovation. The name of an innovation is a key factor in attaining compatibility. The name of a new technology should have a clear meaning to the potential adopter, and this may spur an adoption decision. Complexity of a new technology was the other attribute cited by Rogers. This is the extent to which the technology is seen to be difficult to understand and use. He finally stated that complexity and adoption have an inverse relationship, and that high complexity of a new technology is a major hindrance to its adoption.

The other attribute was trialability. This refers to the extent to which a new technology may be tried before adoption on a limited basis (Shoeb, 2014; Sahin, 2006). The more an innovation is triable, the more likely it is to be adopted. Finally was the observability attribute. Rogers explained observability as the extent to which the outcomes of a new innovation are evident to all. He concluded by citing role modelling and peer observations as important motivational factors in enhancing adoption and diffusion of new technologies (Sahin, 2006).

The second component of diffusion process highlighted by Rogers was Communication Channels. As cited in (Sahin, 2006) Rogers referred communication as the process by which members of a society or organization generate and distribute information among themselves for the purpose of mutual understanding. The communication is enabled by various channels or media between the members. Mass media and interpersonal communication are two communication channels. Rogers identified mass media with its element such as TV, radio, and newspapers as a prime channel of communication. He also cited interpersonal communication as an equally useful channel for effective communication among individuals.

Communication channels were strongly linked with the innovation decision making process by potential adopters. Rogers identified five steps in the innovation-decision process. These are knowledge stage, persuasion stage, decision stage, implementation stage, and confirmation stage (Sahin, 2006). In the knowledge step, the potential adopter gets and seeks more information about an innovation. In this stage, the potential adopter tries to establish the nature of the innovation, how it works and how she can benefit from it. According to Rogers, the types of knowledge addressed here are awareness knowledge, how-to-knowledge, and principles knowledge. Awareness knowledge refers to information on the innovation’s existence and its benefits. This may make an individual like the innovation, seek more information and eventually decide to adopt. How-to-knowledge refers to information on how to make use of an innovation correctly. To improve chances of adoption of an innovation, a potential adopter need to have sufficient how-to-knowledge before the trial of that innovation. Principles-knowledge includes the functioning principles describing how and why an innovation works. The persuasion stage follows the knowledge stage in the innovation decision making process. It helps the individual shape his or her attitude about the innovation hopefully leading to adoption. The degree of uncertainty on whether an innovation works and social approval (by colleagues, by peers, etc.) may influence an individual’s assessment and final decision to adopt or not to adopt the innovation.

The decision stage is where the individual chooses to adopt or reject the innovation (Miranda, Farias, Schwartz, & Almeida, 2016). Rogers noted that if an innovation can be given on some limited trial basis, it was adopted more quickly. This was because most people wish to try an innovation in their own setup before making the adoption decision. However, rejection is also possible in every stage of the innovation-decision process. The next stage is implementation stage. This is a stage in which the innovation is put into practical use. Existence of uncertainty on workability of the innovation in the mind of the potential adopter is still a challenge in this stage and there is need for technical assistance to help reduce the uncertainty about the innovation and its consequences. Re-invention, the extent to which a new technology can be altered or modified by a potential adopter may also happen at this stage. Rogers finally observed that more and more of reinvention of an innovation steadily increases the adoption rate of that innovation. The final stage was the he confirmation stage. By this stage the adoption decision already has been made, but individual looks for support for his or her decision. According to Rogers as cited in (Sahin, 2006) the adoption decision can be rescinded if the individual experiences post adoption dissonance about the innovation. There is, therefore, need for support by adoption agents to improve on the attitude of the individual towards the innovation and adoption decision. This support promotes later adoption, but if lacking may result in or discontinuance. Discontinuance may occur when the individual rejects the innovation to adopt a better innovation replacing it (replacement discontinuance) or because he or she is not satisfied with its performance (disenchantment discontinuance). Another explanation commonly made of discontinuance decision is that the innovation may not be meeting the needs of the individual.

Time was the third component of diffusion in Rogers' theory. Adoption process, from awareness to final adoption, requires considerable time to occur (Rogers, 1976). A social system was the last element of the new technology diffusion process. Rogers as cited in (Sahin, 2006) defined a social system as a set of interconnected units involved in common problem solving efforts that help them accomplish common goals. Organization structure is a common name for such a system. He finally asserted that the nature of a social system highly determine how innovative members of the system are.

Rogers further observed that people will take up new innovations at different times and at differing rates. He classified the adoption process using the different rates of adoption. He came up with a classification comprising of innovators (the first to adopt), early adopters, early majority, late majority and laggards (the last to adopt). The technology diffusion model is a derivative of the "bell-shaped" normal distribution curve, in which the curve depicts the frequency of individuals or organizations adopting a product over time. When the cumulative number of adopters is plotted, the result is an S-shaped (sigmoid) pattern. This is illustrated in figure 2.1 below.

Beyond the above discussed factors that influence technology adoption, Rogers identified another class of factors that apply to technology adoption by organizations. He referred to them as organizational structural characteristics that influence innovativeness. These are organization centralization, organization complexity, organization formalization, organization interconnectedness and Organizational slack (Rogers, 2003).

Centralization refers to the extent to which power and control in an organization are centralized in the hands of a few individuals. This centralization has been found to result in negative innovativeness. This means that the more power is centralized in an organization, the less innovative its members and the organization become. The variety of novel and creative ideas in an organization tend to be limited when power and control are dominated by a few central leaders. Complexity refers to the extent to which members of the organization are perceived to possess a relatively high level of knowledge, skills and expertise, which in-turn is measured in terms of members' spectrum of occupational specialties and their levels of professionalism (Rogers, 2003). Complexity is said to enhance organizational members' potential for conception and generation of innovations.

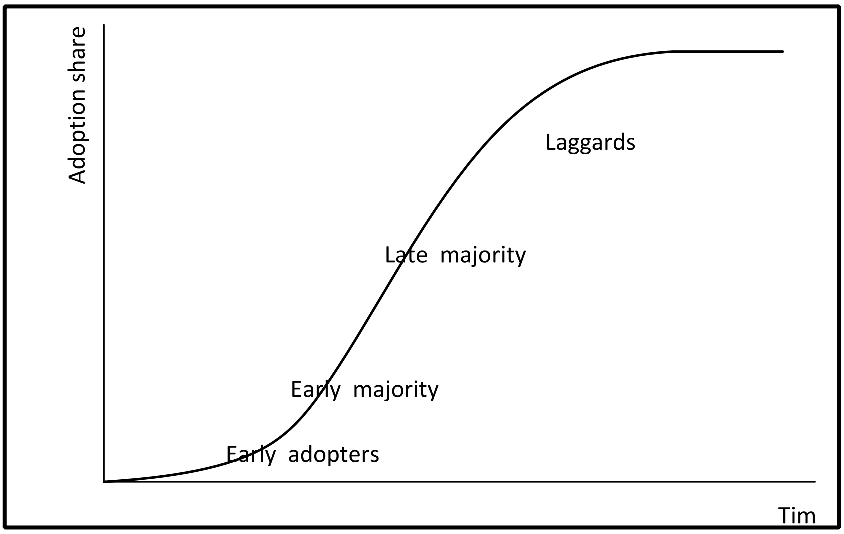

Figure 2.1: The S Curve of Technology *(Source: Sahin, 2006)*

Formalization is about the extent to which the organization emphasizes adherence to rules and procedures in the various functions and roles of the members. Formalization is said to hinder conception of innovations by members of the organization, but may encourage implementation of innovations. Interconnectedness refers to the extent to members of an organization are connected through interpersonal links. Novel ideas will permeate and spread easily among organization members if there is a good level of interconnectedness, and this will in-turn enhance organizational innovativeness. Organizational slack measures the level of existence of uncommitted resources in an organization. It is positively associated to organizational innovativeness, meaning the more uncommitted resources an organization has, the more it is likely to make positive new technology adoption decisions. Slack provides capacity for innovation that is otherwise lacking when there is scarcity in an organization (Rogers, 2003).

In summary, according to Rogers, adoption of a new technology will first depend on its attributes such as its advantages, ease of use, trial ability and observability. Another attribute is economic attractiveness with indicators such as cost and profitability. Other variables he brought out are information communication & promotion efforts by change agents, and nature, norms and interconnectedness of the social system. For adoption by organizations specifically, he highlighted the importance of organization structure characteristics.

This study has to a big extent relied on the above discussed Roger's theory. The concept of CSPT adoption is aligned to this theory and the variables of CSPT attributes, CSPT awareness creation and organization structure characteristics are derivatives of the theory.

2.3.2 Awareness Raising Model

This model was developed from theories, principles and techniques from experiences and projects that succeeded in delivering desired results in the United Nations Literacy Decade

2003-2012 (Sayers, 2006). It posits that to create awareness of an idea or area of concern involves endeavours to inform a community attitudes, behaviours and beliefs. Using information you are able to change attitudes positively, direct desired behaviours and entrench new desired beliefs that will help the organization attain commonly defined objectives. The model identifies commonly used approaches for awareness creation and groups them into five broad categories. These are person to person communication, mass media communication, education process, public relations initiatives and advocacy.

Personal communication is considered the most powerful method of communicating and persuading people buy a new idea. This is particularly so if the communication is from an individual or organisation with recognised credibility (Sayers, 2006). The personal communication can be implemented through various initiatives such as conducting meetings for organization members and all stakeholders, conduct seminars and webinars, educational and technical workshops, and social media interactions. Mass communication involves use of printed materials (such as, billboards, brochures, cartoons, comics, pamphlets, posters and resource books), audio-visual resources (such as pre-recorded cassettes, videos, CDs and DVDs), electronic media (use of text and graphic websites, emails prompts and discussions, and blogs) and media interviews. Others include feature articles and announcements extracted from newspapers and magazines that can be accessed from the internet. SMS messages made directly to individuals' cel-phones are commonly used.

Education is intended to give awareness for long-term benefits. It provides target subjects with knowledge, skills, attitudes and motivation for change (Sayers, 2006) . To create awareness for new ideas various activities are implemented. One of them is training of trainers. Others are the formal education programs, and informal educational programs which are conducted in secondary and high schools, post-secondary school colleges, and at adult learning centres and libraries. Awareness is also enhanced in public idea or product exhibitions and displays.

Public Relations involves activities targeting maintaining and promoting the reputation and credibility of an organization. As cited in (Sayers, 2006) the Chartered Institute of Public Relations in Britain describes public relation as the planned and sustained effort to establish and maintain goodwill and mutual understanding between an organisation and its publics (audience and stakeholders). Commonly practiced activities under public relations include media briefs on the organization or the new idea, news creating activities (for example clean-ups), and corporate responsibility initiatives.

Advocacy and lobbying efforts are also crucial to help garner continued support from the, government, development organizations and the civil society. This involves efforts like engaging in strategic alliances with the government, civil society organizations and other stakeholders. Organization members also target politicians, government ministers and officials that are in power to create a good rapport and goodwill that will spur support of organizations initiatives and products by government and the public.

This model had a great input for this study in the analysis of awareness creation for CSPT technology among tea factories. Even though it was not designed for technology diffusion awareness creation, it spells out the key mechanisms and forums through which awareness can be enhanced among public organizations, which the researcher felt were applicable to awareness creation among tea factories.

2.3.3 Commercial Financial Instruments for Renewable Energy Model

This model was authored by Dr Peter Lindlein and Dr. Wolfgang Mostert for the World Bank‘s Initiative, "Financing Renewable Energies in International Financial Cooperation” (Lindlein & Mostert, 2005). The authors of this model first outlined the demand profile for renewable projects financing. This demand is characterized by clients (investors, entrepreneurs and households) that have minimal experience and track-record; need for “patient capital” (both credit and equity); high external financing share; and very long term maturity period. Other characteristics were low Interest rate and limited capacity for security and collateral. For this profile the authors came up with benchmark commercial finance tools that would be used in identifying financing mechanisms in funding renewable energy projects. These tools are equity finance, debt financing, mezzanine finance and subordinated debt, and sales-lease-back arrangements.

Equity funding may be capital injections from the owners or by third party capital gearing schemes such as venture capital funds and family members’ contributions. This is important because lenders expect borrowers to take an equity stake in their projects to show their commitment and confidence in their project (Lindlein & Mostert, 2005). Lenders will usually expect about 20% of the project cost to be raised by the borrower, and RET projects which are perceived to have higher risks may be expected to have a higher equity ratio requirement. Debt financing is to be in form of loans and other credit forms offered by commercial banks and other finance institutions. Bonds are another tool in this classification. They are borrowing instruments issued by companies to investors when they want to raise capital for various purposes. Sales-Lease-Back arrangements will involve financiers for RET equipment whereby the financier keeps ownership of the financed assets, thereby obviating the need for other collateral security.

This model recommends access to finance mechanisms for renewable energy technologies, a category befitting CSPT. Nevertheless, mezzanine finance and subordinated debt initiatives are foreign in the Kenyan financial landscape and were therefore not investigated in this study. Capital, debt, grants and insurance schemes mechanisms were investigated as sources of funding for acquisition of CSPT for the tea factories.

2.3.4 International Organization for Standardization (ISO) 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.

2.4 Empirical Literature Review

This section comprises a discussion of various studies or projects results previously conducted in technology adoption. Their findings were analysed to clarify the independent variables outlined in the theories in the previous section, and help clarify this study's conceptual framework.

2.4.1 CSPT Attributes and the Adoption of CSPT

As articulated in Rogers diffusion theory reviewed earlier, an innovations important attributes are relative advantage, compatibility, complexity, trialability, and observability. These attributes have been showcased in many projects through awareness campaigns and demonstrations. In the project, Energy Conservation in Small Sector Tea Processing Units in South India, these attributes were emphasized in 35 awareness seminars, training programmes, 15 quarterly newsletters, 15 meetings with associations, a project website, and about 100 one-on-one meetings held between tea factory owners and experts (Ocampo & Maithel, 2012). Beyond these, 30 demonstration projects were conducted. Further, liaison with energy equipment manufacturers was conducted to customize equipment for capacities required for the tea sector. This led to the acceptance of the suppliers as 'value-adding energy service providers' rather than just 'salesmen of equipment'. The outcome was that 90 tea factories implemented energy reforms with project support and another 24 factories without project support bringing to 114 the total number of factories that adopted the new technologies.

In an on-going project, Market Development & Promotion of Solar Concentrators for Process Heat Applications in India, one of the objectives of the project was to promote enhanced understanding of CSH technologies and their applications. The attributes were mainly exhibited through demonstrations. Component 3 in the implementation of this project was pilot demonstration of CSH technologies for various applications (Akker & Aggarwal, 2015). A number of activities were lined up for the purpose of showcasing the viability of the CSH technologies. These were a website on CSTs, monthly newsletters and publications, development of case studies & success stories, training manuals for installers & manufacturers/suppliers, and a handbook on CSTs. Further, a technology assessment and performance evaluation is done of existing projects (Singhal, 2017). Reports on the evaluation aid policy makers identify salient features and limitations of CSTs when coming up with CSTs adoption strategies.

Other studies have highlighted the pole position of an innovations attributes in influencing adoption decision. One of these studies investigated the role of attributes in explaining adoption of the interbank mobile payment service in an Indian context (Kapoor, Yogesh, & Michael, 2013). The study examined the role of innovation attributes in the adoption of interbank mobile service among 330 respondents in Delhi, Kolkata, Mumbai, and Bangalore cities in India. The attributes investigated were as stipulated in Rogers' diffusion of innovation theory. These were relative advantage, compatibility, complexity, cost, triability and observability. The study found that relative advantage, compatibility, cost, complexity and triability had a significant influence on the adoption of the interbank mobile payment service. However, observability attribute was found to have a poor relationship with adoption of interbank mobile payment service.

Another study was carried out in Nairobi, Kenya, investigating the role of technology characteristics in the adoption, rejection, and discontinued use of open source software for development (Tully, 2015). It focused on organizational adoption decisions of a new ICT platform known as Ushahidi, which was designed for collecting, aggregating and mapping information. The study was carried out among seven firms in Nairobi between December 2008 and July 2012. The study report indicates that triability, observability, complexity and compatibility were key influencers of the adoption of Ushahidi platform. Beyond this, the study identified flexibility also as an important attribute to influence adoption.

There is another research study conducted on technological attributes that influence Radio Frequency Identification (RFID) technology adoption in logistics organizations (Sibayan, 2015). The study investigated the technological factors considered when adopting RFID technology which is an innovation that give visibility for the management process in logistic organizations. The study was a review of cases from the past in various countries and was aimed at enhancing managers and leaders insight in adoption decision making concerning RFID technology in logistic organizations. It focussed on the compatibility, complexity and competence attributes and their influence on the adoption of RFID technology. The study found that compatibility, complexity and competence attributes influenced decision makers in adopting RFID technology. Further, it was reported that the effects of these attributes is mitigated when the innovation is made explicit to all members of the organization, and that making the technology explicit minimizes uncertainty of the technology. Finally the study found out that the more educated and knowledgeable an organization is about the RFID innovation the more likely that the organization will adopt the technology.

Another study was conducted on the role of innovation attributes on adoption of renewable energy technologies. The study was carried out in Mexico with a purpose of analysing innovation attributes and their effect on the adoption of solar renewable energy innovations for town households (Pavel & Mercado, 2017). It was carried out among 291 town consumers. The study report indicate that compatibility was found to be a major influencer of adoption, but triability and relative advantage showed little influence on adoption of the solar technologies.

In Taiwan a study was conducted in 2017 on drives of smart-watch adoption intention, comparing Apple and non-Apple watches (Hsiao, 2017). The study targeted smart-watch users in Taiwan with the purpose of identifying the different factors that affect users' intention to adopt the Apple Watch or other smart-watches. The attributes investigated were compatibility, relative advantage, complexity, and design aesthetics. On completion, perceived compatibility, relative advantage, and design aesthetics were shown to have a positive impact on adoption intention. Perceived complexity was found to have no significant effect on smart-watch adoption decision.

The effect of relative advantage was particularly strong especially for the Apple smart-watch group. The explanation was that quality and performance of Apple products were usually better than those of other brands', and therefore relative advantage helped users better manage their adoption decision task (Hsiao, 2017). Complexity was negatively associated to adoption intention in the non-Apple Smart-watch Group only. The reason was that when users consider buying non-Apple smart-watches, they become concerned about the complexity of the operating system since these other smart-watches are less well-known. Complexity was, therefore, shown to be a key factor in the adoption of non-Apple smart-watches. The design of the smart-watch was found important and had a positive effect on adoption intention. A watch generally serves as an adornment, so design aesthetics were also an important aspect of a smart-watch.

The results of this study affirm prior propositions of innovation adoption and diffusion theories that perceived product attributes have a relatively strong influence on adoption intention. Those found to have a positive effect on adoption in this study were relative advantage, compatibility and design aesthetics.

Yet another study on product attributes and adoption of new products was carried out in Shangai China in 2018 (Chao, Reid, Lai & Reimers, 2019). Amongst other objectives, the study investigated influence of perceived new product characteristics (PNPCs) on Chinese consumers' new product adoption behavior. The focus was on the five innovation characteristics articulated in the innovation diffusion model (Rogers, 2003) cited earlier in this chapter namely relative advantage, compatibility, complexity, observability, and trialability. The study also considered price sensitivity to new products and the brand names of new products as additional characteristics. The respondents were randomly selected from individuals passing by the front of shopping and comprised a final sample of 316.

Even though influence of individual attributes on adoption decisions were not documented, the results of the study demonstrated that PNPCs were the primary drivers of new product adoption (Chao et al, 2019). The results confirmed PNPCs affect Chinese innovative buying behavior.

The above discussion on technological attributes and their influence on adoption of new technologies bring out five common attributes that may be crucial in enhancing adoption of new technologies. These are relative advantage, triability, compatibility, complexity and cost. However, the different studies have highlighted differing combinations of these attributes, and even in some rare cases, additional attributes in the name of flexibility and competence were introduced.

2.4.2 CSPT Awareness and the Adoption of CSPT

Virtually all literatures previously reviewed have cited lack of awareness of solar technologies as a barrier to their adoption. They expressed the view that awareness levels of target markets is low on available solar technologies and their benefits, coupled with lack of awareness on the hazards of continued use of fossil fuels. In response to this challenge several initiatives implemented in different places are discussed below.

In the UNDP/GEF project currently being implemented in India focusing on growth and advancement of solar concentrators for process heat (Akker & Aggarwal, 2015), one of the main objects of the project was to promote enhanced understanding of CSH technologies, their applications and markets. For this purpose a market development programme was laid out and implemented for industrial, commercial and institutional sectors (Singhal, 2015). By 2015 40 workshops on CSTs had been conducted and several video films on successful CST projects placed on websites. A monthly newsletter was started and made available at www.insolthermtimes.in and a quarterly magazine on CSTs, SUNFOCUS, developed and distributed to about 700 stakeholders. Advertisements on CSTs were released on national newspapers and magazines, and a national toll-free helpline 1800 2 33 44 77 was launched. A new website www.chindia.in was developed and together with the ministry websites made available information on CSTs suitability, costs and payback. Further, exposure trips to show case installations of CSTs to potential users were organized in conjunction with the University of Pune. The project is expected to result in 30 CSH demonstration and 60 replication projects. It is also expected to have successfully introduced five CSH technologies in India complete with a supply chain. Further it is expected to have an outcome of carbon savings of 39,200 tonnes per year and replace 3.15 million litres of fuel oil annually (Singhal, 2017). These initiatives have highlighted the importance of CST and raised confidence of investors. They also set international benchmarks for solar thermal market strategy.

Another project has been carried out in India by UNDP and GEF in conjunction with the India government. This is project, Energy Conservation in Small Sector Tea Processing Units in South India project, commenced in 2008 and ended in 2012 (Ocampo & Maithel, 2012). The very first objective of this project was to create awareness among stakeholders on efficient and sustainable energy technologies that are ideal for tea factories and the benefits that accrue to the factories that adopt the technologies (Ocampo & Maithel, 2012). On completion this goal achievement was classified as very satisfactory. The project was highly praised for the vast awareness generated on energy efficiency and renewable energy technologies by use of, technical seminars, meetings with various stakeholders, monthly newsletters, video films and web-sites. A total of 35 awareness seminars were conducted, several training programmes implemented, and many meetings carried out with all stakeholders.

Through these awareness initiatives almost all the 266 tea production units in South India were impacted. Over the project implementation phase, fifteen (15) newsletters were published and circulated in the annual general meetings of the Tea Board. The project initiatives captivated close to 250 of the 256 factories in the region via awareness campaigns and personal visits by experts. The project website contained details on the project features, current and past newsletters, various energy technologies presentations, and other important information such as contact information of suppliers of the technologies. The outcome of the project was awareness by all the 266 tea factories in South India of energy efficiency and sustainability activities and technologies. The project has cultivated an informative ecosystem in the region, introduced an energy score card which is a tool for the factories to self-evaluate on their performance concerning energy use, and a communication link to all interest groups.

Still in India, on realizing the importance of CSH technologies, UNDP in 2014 established a centre for conducting awareness seminars on CST technologies at Brahma Kumaris, Abu road. The centre is run by World Renewal Spiritual Trust (WRST), an organization that has knowledge and experience of developing and demonstrating CST projects for over 20 years (Jayasimha, 2017). The centre develops and demonstrates various CSH projects. This provides opportunity for participants to learn and explore existing functional systems that they can adopt. UNIDO has an on-going project in India titled 'Promoting Business Models for Increasing Penetration and Scaling up of Solar Energy'. Among its key components is awareness creation (Rawlins & Ashcroft, 2013). Activities laid out for awareness creation were awareness workshops for the business community; establishment of knowledge sharing forums; and compilation of project results, successful case studies, and established best practices to enable learning and enhance replications of the success cases.

Awareness creation is also a key ingredient of another UNIDO project in Malaysia titled GHG Emissions Reductions in Targeted Industrial Sub-Sectors through EE and Application of Solar Thermal Systems. The project is on-going having started in 2014 and expected completion by 2019 (GEF, 2017). The project aims at reduction of GHG emissions through promotion and demonstration of sector-specific energy efficiency enhancements and solar heat energy technology usage in the industry. Targeted industries include rubber gloves, textile, food & beverage, and agri-business industries. It targets enhanced awareness among industry management to enable them make decisions to take up solar thermal technologies.

Through awareness and other initiatives at least 10 factories are expected to implement solar thermal technology projects.

Awareness as a catalyst for adoption is highlighted in several other cases. One case is a study done in Kenya on technology awareness and the adoption of improved pigeon pea varieties (Simtowe, Muange, Munyua, & Diagne, 2012). The study aimed at analysing patterns of adoption of improved pigeon pea varieties. Study was carried out among 414 households between August and September 2008 and the results presented in an international agricultural economists' conference in Brazil in 2012. The study report indicated that awareness was a major determinant of adoption of the superior varieties. It was noted that regions with non-exposure to the new varieties had lagged behind in adoption by 12%. The study further found that most of the awareness was through informal forums, especially socialization among farmers. However, potential for formal forums of awareness creation was recognized and on-farm trials, demonstration plots, field days for farmers, and agricultural shows were cited as important forums.

A similar study has been conducted in Ireland focusing on the adoption of microgeneration technologies (Claudy, O'Driscoll, Michelsen, & Mullen, 2010). The study was done in 2009 among 1010 respondents investigating awareness of microgeneration technology and its adoption. The study has a conclusion that awareness is a prelude for adoption of the microgeneration technology. Schools, universities and the internet were singled out as very important vehicles for awareness creation. Another study is the study on awareness and the adoption of 3G phone technologies in India (Velmurugan & Velmurugan, 2014). The report from this study highly underscores the significance of awareness creation for adoption purpose. The authors emphasized the need for education on the 3G technology to improve on its adoption. However, forums and mechanisms for awareness creation were not suggested.

A technical consultant report by Asian Development Bank (ADB) in 2012 highlighted awareness measures recommended for the promotion of CSP industry in China (ADB, 2012). The report was a summary of Peoples Republic of China (PRC) Concentrating Solar Thermal Power Development Program funded by ADB. Among the constraints of CSP technologies use and investment in PRC cited in the report was lack of knowledge, especially among design institutions and authorities. To alleviate this situation, information dissemination was recommended, particularly through workshops, conferences, publications and study tours for main stakeholders and partners in the CSP value chain. Other recommendations were establishment of technical and commercial demonstrations, and encouragement of participation and contribution in international networks.

Investigation of importance of awareness creation was also a key objective in a study in Lagos, Nigeria, on strategies for promotion of Green Building Technologies (GBTs) adoption in the construction industry (Chan, Darko & Ameyaw, 2017). GBTs are technologies that are made part of building design and construction to make the building sustainable, such as solar system technology, green roof and wall technologies, and heat pump technology. Adopting GBTs delivers a wide variety of economic, social, and environmental benefits and, plus considering the growing awareness of climate change, these benefits drive the push for the adoption and development of GBTs. The objective of the study was to identify strategies that were important for promotion of GBTs adoption in construction, among them availability of better information on cost and benefits of GBTs, and public awareness creation through workshops, seminars, and conferences. A survey was conducted to collect (through e-mail) and analyze the professional views of green building experts from different countries around the world. In the findings, availability of better information on cost and benefits of GBTs was scored the second best strategy, implying that making relevant information available was considered a key means of promoting GBTs adoption (Chan et al, 2017). Considering the high initial investment, stakeholders with adequate, accurate, and better information on lifecycle benefits of adopting GBTs are more likely to adopt GBTs.

The above cited studies and projects repeatedly underscore the importance of awareness creation as a trigger of adoption of new technologies.

2.4.3 Organization Complexity and Adoption of CSPT

As indicated earlier one organization structure characteristic is Complexity. This refers to the extent to which an organization's members are perceived to be knowledgeable and skilful. Lack of adequate knowledge and skills have been cited in most of the literatures reviewed in this chapter. Mitigating approaches from past studies and project reports are now discussed in this section.

First are the findings of a study carried out in Asia on the role of education and training in absorptive capacity of international technology transfer in the aerospace sector. This study, a synthesis of several empirical studies, discussed education and training in connection to absorption capacity (AC) in Newly Industrialized Countries (NIC's) in Asia (Heidena, Pohlb, Mansorc & Genderen, 2015). It focused on the transition of aerospace and technologies to NIC's and the central task education and training carries out in the establishment of absorption capacity in the NIC’s so as to take up the aerospace technology and knowledge being rendered. However, the authors posit that the guidelines and policies they have prescribed may be applied in other technology areas and industries beyond the aerospace industry.

As reported in these studies, absorption capacity precedes organizational learning because it is about internal resources that energize an organization's ability to comprehend, accept and implement new ideas for commercial gain. Therefore, the uptake of new ideas is a product of organizational capabilities that enable an organization to quickly identify and fully digest outside sources of incoming knowledge which replace or modify existing information (Heidena et al, 2015). The authors came up with seven important factors concerning education and training in aerospace technology transition to NIC's. The seven issues start with recognition of the groups or individuals who need training such as decision-makers, planners, managers, teachers, opinion leaders, Professionals, engineers, technicians, researchers, students and the general public. Other factors were the number of target trainees, identification of training venues, the period the training will take, the different types of training to be offered, identifying the trainers of groups or individuals and identifying financiers of the training programs. The above factors need clear policy guidelines to enhance the success of the education and training programs.

Back to India and the solar concentrators for process heat applications in India project. The project aimed to support initiatives of the Government of India to encourage the use of solar concentrators for process heat generation. This was to be achieved through trying to minimize existing barriers of the technology transfer such as, lack of awareness, lack of technical capacity, and financial barriers (Akker & Aggarwal, 2015). Component 2 of the project was to provide awareness and capacity building. One of the expected outcomes from this component was more technical capability and awareness of all stakeholders of CSH systems used in industries and institutions for heat generation. Training activities lined out to achieve this goal included identifying training needs of various groups; compilation of learning materials for training of potential consumers, technology installers, technology dealers, technology manufacturers, etc; organization of learning programs for various groups, human resource development of Ph.Ds and M.Techs in the area of CSTs at Solar Energy Centres and several other academic organizations; and organization of global learning trips for various groups to expose them to CSTs commercially successful in other countries. A training centre on CSTs has also been established at Brahma Kumaris Ashram, Mount Abu for skills improvement for manufacturers, installers and operators (Singhal, 2015). As a result technological skills and knowhow have been enriched through a technical training program on CSTs operations, CSTs maintenance and CSTs troubleshooting, plus manuals have been developed for each of the six (6) CSH technologies, both in English and Hindi. These efforts have helped generate over 100 trained operators and maintenance technicians of CSTs in India.

Significance of training in technology adoption was also emphasized in a study conducted in Tanzania on the impact of technological training on the adoption of technologies in rice farming (Nakano et al, 2015). The study investigated the influence of JICA training on the adoption of rice cultivation technologies in an irrigation scheme in Tanzania. The authors utilized a 5 year panel data and came up with a conclusion indicating that trained farmers embraced the new technologies more easily and faster.

Centralization is another organization characteristic likely to influence organization innovativeness. One firm whose innovativeness has been cited to have been hindered by centralization is Samsung Electronics. Samsung Electronics is a company owned by the South Korean multinational company, known as Samsung. Its key products include smart phones, tablets, personal computers, and televisions. The company has been the global leader in information technology products based on revenue generation since 2009 (Song & Oliver, 2010). Samsung is a giant conglomerate (chaebol) which generates 17 percent of GDP of South Korea. Despite its high rank in the world market, Samsung Electronics has been highly criticised for lacking innovation. The company has faced legal action from her competitor, Apple, for infringing on their patent in 2011 (Kane & Sherr, 2011). The legal action was later dropped but, Samsung Electronics clients have continually complained of lack of innovation in the company's products.

A research conducted by Jeen Chun (2015) reported Samsung Electronics to be a mechanistic organization whose mechanistic organizational structure has hampered the organizational innovation. The Confucius culture of Korea influenced the company's culture, which embrace being collective, being risk averse and power distant. This culture of Samsung Electronics caused its organizational structure to be mechanistic, which in-turn does not encourage creativity of individuals and by extension hindering organizational innovation of the company.

2.4.4 Access to Financial Resources and the Adoption of CSPT

Access to finance has been cited in the theoretical reviews discussed earlier in this chapter as a major barrier and requirement for energy technologies adoption schemes. In this section an analysis of past financing schemes is done, bringing out key parameters of the concept of access to finance. To begin with is a study report from the Mediterranean Countries titled Financial Support Mechanisms for Distributed Solar Technologies and

Energy Efficiency Deployment in Mediterranean Countries. This study was conducted in October 2014 by Mediterranean Development of Support Schemes for Solar Initiatives and Renewable Energies (MEDDESIRE) in November 2014 (Topo, Moretta, Glorioso & Pansini, 2014). The objective of the study was to identify the financial support mechanisms that stimulate the diffusion of solar technologies in the Mediterranean countries. The study identified three ways to stimulate renewable energy investments. The first one was reducing cost of the investment through fiscal incentives or direct subsidies, providing incentives for the private sector to produce energy through renewable energy. These would include quota based support mechanisms, tender systems, net metering, feed-in tariffs and tax credits. The second mechanism recommended was increasing cash-flow through schemes like public private partnership, credit lines, project loan facilities, private equity funds, venture capital funds and project development grants. The last one was reducing the risk associated with the project through soft loans, guarantees and contract guarantees.

In the UNDP 'Energy Conservation in Small Tea Processing Units in South India' project, a key objective was to remove financial barriers that hinder adoption of renewable energy technologies. As an intervention commercial lending for investment in RE technologies was implemented. A risk insurance scheme was also developed and implemented. Nevertheless, during the project the project team realized access to finance was not a key barrier in investment in RE technologies (Ocampo & Maithel, 2012). Awareness of the technologies and capacity to adopt were found to be more profound interventions. In the project in India mentioned earlier, promoting solar concentrators for process heat applications in India, component 4 involved encompassing a sustainable financing mechanism for adoption of CSH technologies (Akker & Aggarwal, 2015). This in-turn involved promotion of understanding of financial viability of CSH projects, and initiation of favourable financial policies to encourage increased use of CSH technologies. Expected outputs were documented financial viability cases of CSH investments and banks/financial institutions identified to lend investors in CSH technologies at priority lending rates (as low as 5%) (UNDP, 2015; Akker & Aggarwal, 2015). By the third year of the project there was not a single documented case of CSH technologies financial viability. Though 15 banks/financial institutions had been identified for lending, no project had been developed using this benefit.

A study was recently conducted on Impact of political and economic barriers for concentrating solar power in Sub-Saharan Africa (Labordena, Patt, Bazilian, Howells & lilliestam, 2017). The study observed that CSP technologies are capital-intense investments, and are especially sensitive to financing risks, which drive up the cost of capital. The study highlighted that financing costs are also usually higher in developing countries than in developed countries. This was attributed to the extra reward demanded by investors and lenders to compensate them for perceived or actual higher risks emanating from matters like politics, long and uncertain permission processes, poor administration and corruption. For example actual weighted average cost of capital (WACC) in North Africa is more than twice as high as in Europe, and policies bringing the North African WACC down to European levels could decrease CSP costs by 40% (Labordena et al, 2017). To address this, there have been international efforts to lower such barriers and help improve legal, policy and regulatory environments to minimize such risks and enhance CSP technologies investments. The study concluded that the key aspect to tackle for making CSP competitive across SSA is finance. Policies to de-risk CSP finance to OECD levels could make power from CSP competitive with coal power in every country in SSA. The measure that will support CSP the most is the provision of low-risk finance, through schemes such as long-term power purchase agreements, concessional loans, and loan guarantees.

In Ghana access to credit was found to influence adoption of new technology. This conclusion was made in a study that sought to find out the effect of lack of credit on the adoption of Cocoa Research Institute of Ghana (CRIG) recommended cocoa technologies (Obuobisa, 2015). The study involved 600 farmers and access to credit was found to have a significant influence on the technology adoption.

In South Africa a stakeholder's workshop was held in 2009 on a planned large-scale roll out of CSP technologies (Edkins, Winkler, & Marquard, 2009). The workshop identified the key drivers that would ensure the large scale roll out of CSP technologies. Lack of financial support was raised as a major drawback to the adoption of CSPs and financing mechanisms were suggested. These mechanisms included venture capital, grants from international development organizations, credit, equity, mezzanine debt and insurance covers.

From the above discussions it is apparent that access to finance is considered an important factor in new technology adoption. This seems to be so in the needs analyses and pre-implementation stages. However, as the projects matured it has been noted the access to finance does not seem to have much significance in influencing adoption of new technology.

2.4.5 Technology Standardization and the Adoption of CSPT

As explained earlier in this chapter 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 second best solution to ensure rapid adoption among various industries.

2.5 Research Gap

A review of empirical research has revealed the potential and benefits of energy innovations, particularly in India. It was found to reduce production costs of tea processing and at the same time cut down on carbon emissions of the industry. Efforts of change agents such as UNDP and UNIDO were not only fruitful in enhancing use of the technology among the tea factories but also increased entrepreneurs dealing in the technology. Before their interventions in India, the above named change agents had cited likely hindrances to the adoption of CSPT technologies among tea factories. They included lack of information on the technology and its benefits, technical capacity of factories and dealers, access to financial resources and reluctance to take risk with the novel technology. These challenges were countered in the projects through awareness creation about CSPT, financial barriers removal, technical capacity building and pilot demonstration projects. The completed projects were highly successful.

In Kenya, the next big world producer of tea after India, the CSPT technology had not been adopted by a single factory by 2013 as indicated in the Carbon Trust report cited earlier in this study. No further studies were found directly relevant to the adoption of CSPT in Kenya and particularly to the tea factories run by KTDA. In this scenario it was necessary to find and review credible theories and empirical studies that were likely to fit the case of the tea industries in Kenya. Many were found and their review comprise the bulk of this chapter.

Having reviewed the foregoing literatures, both theoretical and empirical, a number of knowledge gaps were evident. Generally there was scanty information of CSPT adoption and factors influencing its adoption, particularly so when it came to information on the Kenyan scenario. Specifically various literatures were wanting contextually as they were not conducted in Kenya or in the tea industry which were the focus of this study. Others addressed concepts that were not congruent to adoption models embraced in this study, for example addressing just a few of the concepts. Some other literatures' methodologies were insufficient for this study's threshold. For instance some were just desk research with no primary data collection, others targeted just a few respondents, and yet others based their reports on interviews of a few energy technology experts. Lastly several of the study's analytical approach was wanting. Most were descriptive studies with no inferential input and could therefore not deliver the likelihood relationships between the various determinants and CSPT adoption sought for in this study. All these gaps cited in this section were addressed in this study. Key literatures reviewed in this study and their knowledge gaps are outlined in Table 2.1 below.

Table 2.1 Research Gaps

Author/year	Theory/Study	Findings	Research Gaps
Rawlins & Ashcroft, 2013	Report on a study on status and potential of Small-scale Concentrated Solar Power	General approaches to promote adoption of Small-scale Concentrated Solar Power: - Access to finance - Build capacity - Awareness creation	- Contextual - conceptual - Methodological - Analytical
Shoeb, 2014	Diffusion of innovation theory	Determinants of Adoption of innovations	- Contextual - Methodological - Analytical
Sayers, 2006	Awareness Raising Model	5 awareness creating approaches: - person to person	- Contextual - Methodological - Analytical

		- mass media - education process - public relations - advocacy	
Lindlein & Mostert, 2005	Commercial Financial Instruments for Renewable Energy Model	Mechanisms in funding renewable energy projects: - Equity finance - Debt financing - Mezzanine finance - Subordinated debt - Sales-lease-back arrangements.	- Contextual - Methodological - Analytical
ISO, 2013	Guide on Standardization	Rules, guidelines or characteristics of activities or their expected results, for the purpose of attaining optimum level of order	- Contextual - Methodological - Analytical
Ocampo & Maithel, 2012	Project report on Energy Conservation in Small Sector Tea Processing Units in South India	Innovation attributes influencing adoption: - relative advantage, compatibility, complexity, trialability, and observability	- Contextual - Analytical
Akker & Aggarwal, 2015	Project report on UNDP/GEF project in India focusing on growth and advancement of solar concentrators for process heat.	Awareness creation: - Newsletter - Website - Films - Advertisements - Demonstrations	- Contextual - Methodological - Analytical

2.6 Conceptual Framework

A conceptual framework is a written or visual expression of the main concepts, constructs or variables and their suggested relationship between (Vaughan, 2008). The framework gives the structure and content of a study based on literature and personal experience, placed in a logical and sequential design. It helps to clarify the concepts of the study and their proposed relationship. Eventually it provides a context for interpreting study findings and theory development that is useful to practice. This study investigates the relationship between adoption of CSPT (dependent variable) and five independent variables. These are CSPT attributes, CSPT awareness, organization complexity, access to finance, and technology standards. This conceptual framework is illustrated in Figure 2.2.

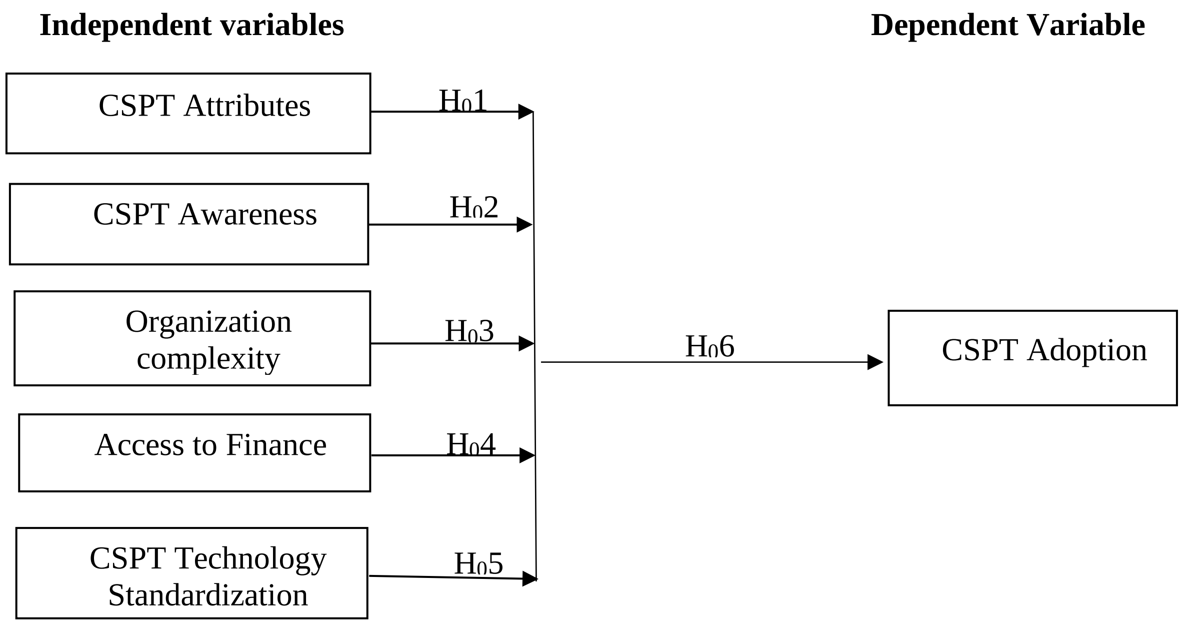

Figure 2.2 Conceptual Framework

2.6.1 CSPT Attributes.

These are the characteristics of the CSPT that may or may not entice potential adopters to adopt the innovation. They include cost effectiveness of the innovation, profitability, compatibility with an individual's needs and the extent to which a technology may be experimented (Sahin, 2006). Others are ease of use and extent to which results of an innovation are visible.

2.6.2 CSPT Awareness.

Awareness creation is a means of making a group people aware of something (ESTIF, 2012). This is a communication campaign aiming at creating or developing a sustainable market for CSPT technology. Potential adopters should be made aware of the advantages and disadvantages of the technology so as to prepare them for its consequences (Sahin, 2006).

2.6.3 Organization Complexity

Complexity refers to the extent to which members of the organization are perceived to possess a relatively high level of knowledge, skills and expertise, which in-turn is measured in terms of members' spectrum of occupational specialties and their levels of professionalism (Rogers, 2003). Complexity is said to enhance organizational members' potential for conception and generation of innovations.

2.6.4 Access to Finance

Access to finance has been cited in all the theoretical and empirical reviews discussed earlier in this chapter as a major requirement for entrepreneurs to engage in business. This is particularly crucial when they are dealing with new innovations with presumed high risk and substantial initial costs. This is the case with CSPT technology and financing schemes were a major component of CSPT projects discussed in the empirical review. Such schemes will promote the diffusion of CSPT technology.

2.6.5 CSPT Technology Standardization

Standardization involves developing and applying rules for a systematic approach to an activity for the benefit of everyone, and particularly to promote optimum economy, taking into consideration the functional conditions and safety issues (Emodi, et al, 2014). Standardization can be used to specific products, or generalized product groupings. An example is the norms, specific requirements, specific methods, specific terms, and specific designations mostly applied in global trade and in science, engineering, industry, agriculture, construction, transportation, culture, public health, and other areas of the international economy. Standardization provides advantages such as improved product quality, more reliable and long lasting service; lower costs of production of products components; ease of access to spare parts for replacements and maintenance; and higher human resource productivity for the manufacture.

2.7 Operational Framework

The operational framework shows the translation of abstracts into measurable indicators (Vaughan, 2008). It brings out dimensions and elements through which a concept is measured. In this study the operational elements of each of the independent variables CSPT attributes, CSPT awareness, organizational complexity, access to finance and CSPT standardization are laid out. It also shows the different stages of the adoption process, which is the dependent variable. The indicators for the five independent variables for this study are illustrated in figure 2.3.

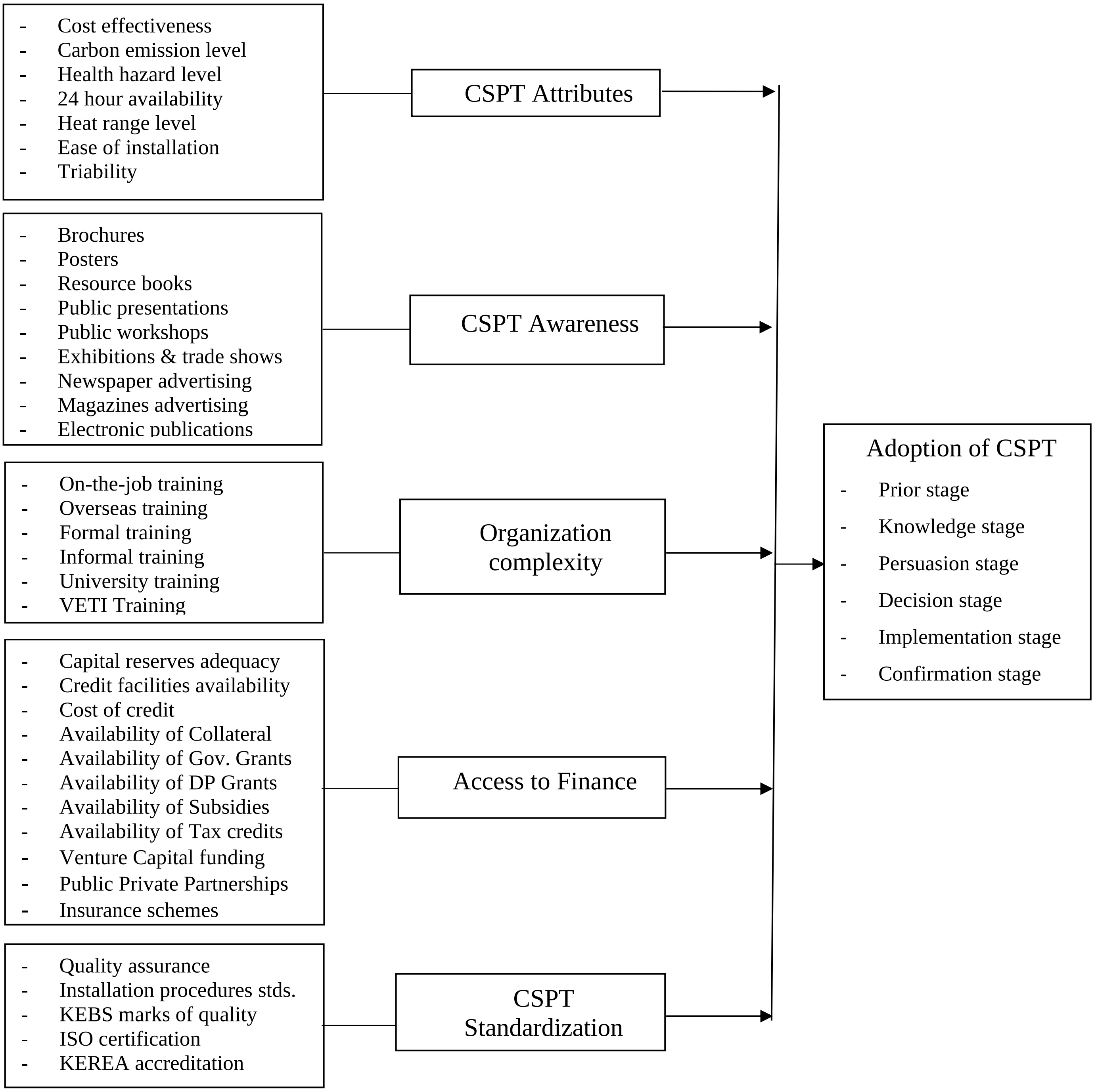

Figure 2.3 Operational Framework

2.8 Hypotheses Development

In this section bases of the study hypotheses are discussed. A hypothesis is a statement, or set of statements, put forward about the occurrence of some specific phenomena, usually meant as a provisional conjecture to guide investigation or as probability in the light of some established facts (Saunders, 2009). Five such propositions are made in this study and are discussed below.

2.8.1 CSPT Attributes and Adoption of CSPT

One of the key contributions of Rogers diffusion theory discussed earlier is that new innovations will be adopted or not based on their characteristics. These were relative advantage over other technologies, compatibility with current systems, complexity of the technology, how triable the technology is, and observability (Shoeb, 2014). Benefits of CSPT for energy production have been discussed earlier in this study, and projects implemented in India illustrated how allure for solar technologies was one of the factors used to attract tea factories to adopt the new technologies. The Indian example may be replicable in Kenya but there are factors that may indicate otherwise. For a start CSPT technology is not the only technology that can deliver the said benefits. Other sources of energy with a sustainability claim just like CSPT are taking a foothold in the market. They include solar PV, wind energy, cogeneration, briquettes and small hydro. Solar PV is said to have a lower cost appeal than CSPT while cogeneration, briquettes and small hydro are likely to be seen as local, easier to generate and more certain products for the sector.

Main grid power supply has also been improving in Kenya. This has been occasioned by enhancement of the hydroelectric plants to raise and make power supply more regular. This has been augmented by the steep development of geothermal subsector which is expected to substantially improve power supply in the country (Saidi, Laura & Seton, 2012). Nuclear energy is also expected to make an entry in the same arena. Kenya also discovered oil in

Turkana in 2012 and it is expected this development might ease on the cost of fuel burden that has been used to make a case for CSPT.

The above discussion identifies a plethora of alternative power sources that equal or better the attributes of CSPT. This puts a doubt as to whether the tea factories will opt to adopt CSPT, and made the study make the following proposition.

$H_0$1: There is no relationship between CSPT attributes and likelihood of adoption of CSPT among the Kenyan tea factories run by KTDA.

2.8.2 CSPT Awareness and Adoption of CSPT

Awareness creation has been highly emphasized as key to inducing uptake of new technologies. It is a communication perspective that assumes that novelty brings about uncertainty and that potential adopters are risk averse (Miller & Garnsey, 2000). The communication or awareness creation is meant to reduce uncertainty, minimize risk aversion perception and actuate the benefits of the new innovation. This is a plausible argument and has been practiced as illustrated in the CSH promotion project in India. Again it may be or not be replicable in diffusion of CSPT among tea factories in Kenya.

First the awareness creation initiative assumes that its content is absent in the target market, which may not be true. The management teams of the tea factories may be well aware of this technology, its benefits and even more important, its shortcomings. After all, information of this technology is highly available, especially on the internet. The said initiative might therefore not be adding any value and will not make the tea factory management make the adoption decisions. The tea factories management, who are the decision makers, may be influenced by other factors beyond the risk and uncertainty addressed here. Personal gains and established cultural practices in the organizations might take centre stage in the source of power decision, regardless of any pleasant communication on CSPT. Finally, suppliers of conventional sources of power (such as oil), and those of other renewable energies will also be making their communications in the market. The potential adopters will therefore be recipient of these different awareness schemes, many made using huge resources that the novel CSPT players may not match, and may find CSPT unconvincing. Based on these possibilities the study made the proposition that:

$H_0$2: There is no relationship between CSPT awareness creation and likelihood of the adoption of CSPT among the Kenyan tea factories run by KTDA.

2.8.3 Organization Complexity and Adoption of CSPT

Training is said to increase the absorption capacity for adoption and diffusion of new technology (Heidana et al, 2015). It was also a key component of the empirical review cases discussed in this study. Just like with awareness it seemed to work with tea factories in South India. However among the Kenyan tea factories some factors might put a spanner into the works. First, training takes time to translate to behaviour. Exposing the tea factory teams to facts, operations and gains of CSPT may not inspire them to act. Furthermore, they may be tied up with long-term power projects that may be hard to abandon midstream just because of the new technology they have just learnt. A case in point is the eucalyptus forests project for supply of biomass fuel, which has been implemented by 34 tea factories (Rawlins & Ashcroft, 2013). The tea factories were therefore not likely to adopt CSPT leading to the following hypothesis:

$H_0$3: There is no relationship between organization complexity and likelihood of the Adoption of CSPT among the Kenyan tea factories run by KTDA.

2.8.4 Access to Finance and Adoption of CSPT

In most of the empirical study reviews done above, access to finance has been highlighted as the most serious hindrance to adoption of new technologies (Topo et al, 2014). In the EE/RE energy promotion project in South India access to finance was a key address but by midterm of the project the project managers discovered it was not a key barrier (Ocampo & Maithel, 2012). This is likely to be the case in Kenya among tea factories. Financial resources are highly available in Kenya, especially for corporate bodies, and the debate is only on the cost. Financial incentives like zero rating of solar products imports, and feed-in tariffs are already in place. Such initiatives can therefore not be seen as incentives and would not spur adoption of CSPT, hence the conclusion:

$H_0$4: There is no relationship between access to finance and likelihood of the adoption of CSPT among the Kenyan tea factories run by KTDA.

2.8.5 CSPT Standardization and Adoption of CSPT

Standardization is a process of formulating and applying rules so as to bring about order (Emodi et al, 2014). It protects customers against sub-standard products. It also provide confidence and trust in new products, and promote best practices in design, installation and maintenance of new product systems. It therefore creates a conducive environment for adoption. However, this might not always be the case. The search for quality products may be circumvented by a number of factors. Budget shortages may make customers opt for cheap products which are likely to be of poor quality, thereby promoting market spoilage and by extension hinder diffusion. Related to this is that usually quality products are expensive and standardization costs will make them even more expensive. The higher costs and prices would mean fewer potential adopters will be attracted. Political influence might also interfere with procurement decisions about quality. Tea factory directors are elected through campaigns that are highly infiltrated by politicians and they would have their say when it comes to making important decisions like the one on source of power energy. The standardization efforts targeting these tea factories were likely to come to nothing, and therefore:

$H_0$5: There is no relationship between CSPT technology standardization and likelihood of the adoption of CSPT among the Kenyan tea factories run by KTDA.

2.9 Chapter Summary

Chapter two presented the theoretical and empirical foundations of this study. It explored literatures on theoretical models on adoption of new technologies pivoting on Everett M. Rogers' adoption model. Empirical studies on adoption of new technologies from different parts of the world were also reviewed with particular emphasis on reports on adoption of renewable technologies (especially concentrated solar technologies) and mechanisms utilized to enhance their adoption. These analyses crystalized in to the conceptual and operational frameworks of this study.

CHAPTER THREE
RESEARCH METHODOLOGY

3.1 Introduction

This chapter discusses research design and methodologies that were applied in this study. These include research philosophy, research design, target population, and data collection and analysis procedures.

3.2 Research Philosophy

Research philosophy refers to a researcher's view on how knowledge is developed and the nature of the knowledge developed (Saunders et al, 2009). It helps clarify researchers' view of the nature of reality (ontology), what makes up acceptable knowledge (epistemology), and the role of values in research (axiology). In turn, this informs the direction of data collection techniques appropriate for a study. There are several research philosophies but the common ones used in social science are positivism and interpretivism.

Positivism adopts a stance of the natural scientists that emphasize working with observable social reality that end up in law-like generalizations (Saunders et al, 2009). According to this view only observable phenomena and a researcher independent of the process can provide credible data. This means that data collection techniques are highly structured, involve clear measurement units, and are quantitative (Saunders et al, 2009).

Interpretivism emphasizes understanding differences between humans in their role as social actors. It is a view that peoples' actions and their views of other actions will depend on their interpretation of the social world (Zikmund et al, 2013; Saunders et al, 2009). This leads to acceptance of subjective meanings of social phenomena. Focus on details of a situation, reality behind the details, motivating actions, and subjective meanings are taken as credible data sources. Subsequently in data collection small samples, in-depth investigations, and qualitative approaches are emphasized.

Most of the concepts and constructs in this study were best served by the positivism orientation. Investigations on attributes of CSPT, levels and sources of awareness, and access to finance were statements of facts from the respondents rather than their impressions. The same applied to enquiries on organization complexity and standardization variables. The study, therefore, adopted a positivism philosophy.

3.3 Research Design

Research design refers to a master plan that specifies the methods and procedures for collecting and analysing the needed information to answer research questions (Zikmund et al, 2013; Bryman, 2012). It specifies the chosen research strategy, data collection techniques and analysis procedures, and the time horizon over which research study is undertaken.

This study was a cross-sectional survey serving descriptive and explanatory purposes. A survey is a method of collecting primary data based on communication with a representative sample of individuals (Zikmund et al, 2013). A survey is cross- sectional when it involves examining the characteristics of several groups at one point in time. A survey enables the researcher to obtain data about practices, situations or views at one point in time through questionnaires or interviews, which can be examined to detect patterns of association (Bryman, 2012). This method was used to get data from the tea factory unit managers on the factory's CSPT adoption status and on the factors that are likely to make the factories adopt CSPT.

Exploratory study is undertaken to gain familiarity with a phenomenon situation which has not been solved in the past (Sekaran, 2010). When data collected regarding phenomena of interest reveals some pattern, theories can be developed and hypotheses developed for subsequent testing. Exploratory studies can also be carried out where some facts are known about a phenomenon but more information is required for developing a theoretical framework. The area of investigation may also be new or vague that exploration is required to learn something about the dilemma facing managers (Cooper & Shindler, 2011). The focus of this study was to find out the factors likely to enhance the adoption of CSPT, a novel product, by tea factories managed by KTDA. Several factors are documented in various literatures cited earlier in this study, which affect adoption of various solar technologies in various industries and localities. Whether all or some of these factors apply to the subjects of this study was the object of the exploratory purpose of this study.

Descriptive approach is a method used to portray an accurate profile of persons, events or situations (Saunders et al, 2009; Sekaran, 2010). It provides a clear picture of phenomena on which one wishes to collect data on and it can be a prelude to explanatory research. It is used to serve a variety of research objectives. A common one is a description of phenomena or characteristics associated with a subject population (Cooper & Scindler, 2011). This would involve answering who, what, when, where and how questions of a topic. Another objective served by description is estimating of proportions of a population that has certain characteristics, and description will also be used to discover associations among different variables. The descriptive approach was used in this study to illuminate the process heat energy quagmire facing the Kenya tea factories run by KTDA. It covers the response rate, profiles of the KTDA factories and their managers, and the KTDA factory's heat energy uses and sources and the challenges facing the factories due to their current sources of energy heat.

Explanatory research approach is used to establish existence or otherwise of relationships between variables (Saunders et al, 2009). The emphasis is to study a situation or a problem in order to explain the relationships between variables in play in the situation. In this study, therefore, beyond describing phenomena, an analysis was made to establish the extent to which each of the cited factors was likely to influence adoption of CSPT. This was accomplished through an inferential statistics procedure (penalized logistic regression) described later in this chapter.

3.4 Target Population

Population refers to any complete group of entities that share some common set of characteristics (Zikmund et al, 2013). It is the total collection of elements about which one would wish to make some inferences (Cooper & Schindler, 2011). This study's target population was made up of sixty six (66) tea factories in Kenya managed by KTDA. A list of the sixty six factories is presented in appendix IV. The 66 tea factories were spread out in 13 counties in the country. They were divided into seven operational regions namely Aberdare Ranges I, Aberdare Ranges II, Mt. Kenya, Mt. Kenya & Nyambene Hills, Kericho Highlands, Kisii Highlands, and Nandi Hills & Western Highlands. The target respondents of this study were the sixty six (66) unit managers of the tea factories run by KTDA. The factories were serving a total farmers population of 599,032.

3.5 Sampling and Sampling Procedure

Sampling is a process for selecting a small proportion of the population for observation or analysis (Best & Khan, 2011). The idea of sampling involves selecting some elements of a population that can be used to draw conclusions about the entire population (Cooper & Schindler, 2011). Use of sampling reduces the cost of conducting research, speeds up execution and enables researcher convenience. However, these advantages of sampling are less compelling when the population is small (Cooper & Schindler, 2011). When a population is small any sample drawn from it may not be representative of the population and values calculated from such samples may be incorrect estimates of the population values.

The target population of this study was sixty six (66) tea factories run by KTDA. This is a size considerably small and this suggested that a census was the feasible way to go. Census is an investigation of all the individual elements that make up a population (Zikmund et al, 2013). In this study, therefore, all the sixty six factories managed by KTDA were studied.

3.6 Data Collection

Data collection refers to the activity of gathering data for the purpose of analysis, testing hypotheses and answering research questions (Sekaran, 2010). There are several data collection methods and the most commonly used include interviews, observations and questionnaires.

3.6.1 Data Collection Tool

Data collection for this study was by use of questionnaires. Questionnaire is a technique of data collection in which every person is asked to respond to the same set of questions in a predetermined order (Saunders et al, 2009; Bryman, 2012). Particularly a self-completion questionnaire was used. This is a procedure whereby the respondents answer questions by completing the questionnaire themselves. The method is preferred to interviewing for being quicker and faster (Bryman, 2012). It also enables minimal interference from the researcher, no interviewer variability and accords respondents' convenience. The questionnaire composed of mostly closed-ended items and is presented in appendix III.

3.6.2 Data Collection Procedure

Drop and Pick technique was applied with the target population. The questionnaires were dropped by the researcher at the respective factories and later picked on respondents' agreed disposal. This method was preferred to mail and postal questionnaires as it enhanced respondent's response rate (Bryman, 2012).

3.7 Pilot Study

Pilot study involves testing the questionnaire on a small sample so as to identify and eliminate likely problems (Maina, 2016; Zikmund et al, 2013; Bryman, 2012). It helps refine the questionnaire such that respondents will have no problem in answering the questions and there will be no problems in recording the data. The study is also used for testing the validity and reliability of the research tool. Baker, Morall and Turkington (1988) recommended a sample size for piloting purpose to be at least 5% of the study population. For this study a pilot test was carried out with four private tea factories not managed by KTDA. These were Maramba tea factory (Limuru), Emrok tea factory (Nairobi office) Ngorongo tea factory (Kiambu) and Arrotek tea factory (Sotik).

A principal finding from the pilot was that all the four factories had not installed CSPT. This informed the modification of the title of this study from ‘Market drivers for adoption of CSPT among KTDA managed tea factories’ to ‘Determinants of Likelihood of CSPT adoption by KTDA managed tea factories’. This was in recognition of the fact that many of the KTDA run factories might not also have adopted CSPT. This eventually proved to be the case. Further, inferential model for data analysis had to be modified to accommodate the new complex data set. Penalized logistic regression (particularly Firth logistic regression) was adopted instead of the earlier targeted standard logistic regression.

Beyond these, many questionnaire items were reframed to embrace the element of factories that may have not adopted CSPT. Also some items in the questionnaire that seemed to be the same to the respondents were collapsed into one.

3.7.1 Reliability of Data Collection Tool

Reliability is an indicator of a measure’s internal consistency (Zikmund et al, 2013). A measure is reliable when its different attempts at measuring something converge on the same result. If an investigation was repeated, in the same context, with the same methods and with the same participants, similar results would be obtained (Shenton, 2004). Cronbach’s Alpha statistic was used to test the reliability of this study’s reliability. Cronbach’s Alpha statistic is a commonly applied estimate of reliability (Zikmund et al, 2013). It measures how well each item in a measuring tool correlates with other items in the same tool. Coefficient Alpha statistic ranges in value from 0 (meaning no consistency) to 1 (meaning complete consistency). When applying the likert scale it is important to calculate and report Cronbach’s Alpha for internal consistency reliability (Tavakol & Dennick, 2011). Generally a Cronbach’s alpha score of 0.7 to 0.9 or higher is considered good for most studies. This study’s questionnaire reliability was tested using pilot study data, whereby each independent variable’s questionnaire items were tested separately. The predictor variable ‘attributes of CSPT’ sored 0.866, ‘awareness creation’ scored 0.873, ‘organization complexity’ scored 0.771, ‘access to finance’ scored 0.761 and ‘standardization’ scored 0.997. These were all in the acceptable range cited above and therefore suggested a fairly good reliability of the data collection tool.

3.7.2 Validity of Data Collection Tool

Validity refers to the accuracy of a measure in truthfully representing a concept (Zikmund, 2013; Bryman, 2012). Therefore, a validity concern in a research investigation is a concern of whether the tools and procedures applied in the investigation are accurately measuring what they are said to measuring. Zikmund et al (2013) has identified four ways of trying to assess validity. These are face validity, content validity, criterion validity and construct validity. Face validity refers to the subjective agreement among professionals that a measuring tool logically reflects the concept being measured (Zikmund et al, 2013). In this study the questionnaire was presented to technology adoption experts for validation of the questionnaire items.

Content validity refers to the degree to which a measure covers the domain of interest (Zikmund el al, 2013; Sekaran, 2010). It is a question of whether the tool covers the whole scope and does not go beyond. Shenton (2004) refers to this as internal validity. A number of ways have been identified that help attain this validity. One of them is the use of correct operational measures for the concepts being studied, which are derived from those that have been successfully used in comparative projects. Another common approach is triangulation. This involves use of different methods of data collection for a synergy that compensates for their individual shortcomings and exploits their respective benefits (Shenton, 2004). It may also involve use of a wide range of informants whose individual view points and experiences can be verified against others to come up with a truthful construct. In this study empirical studies on adoption of CSPT have been used in identifying the variables and their expected relationships in the study. To further establish internal validity, interviews were conducted with energy specialists at Dedan Kimathi University and at KTDA headquarters.

Criterion validity refers to how practical or pragmatic the measuring tool and its results are (Zikmund et al, 2013; Sekaran, 2010). It addresses the concern that a measure overall truthfully represents a unique concept. It is what is referred to as external validity by Shanton (2004). This is the concern on the extent to which the findings of one study can be applied to other situations. This may be attained by accumulation of findings from studies staged in different settings to generate a more inclusive overall picture. An analysis of CSPT adoption projects in India and particularly in the tea industry have been put together in the previous chapter and are in a big way expected to deliver external validity for this study. All questionnaire items on the different variables are developed through an analysis of the empirical project reports in chapter two.

3.8 Measurement and Scaling Technique

Measurement is a procedure in which a researcher assigns numerals (numbers or symbols) to empirical properties (variables) according to rules (Nachmias & Nachmias, 2009). Measurement gives yardsticks for making distinctions between concepts and the basis for more precise estimation of degrees of relationship between variables (Bryman, 2012). In research four levels of measurement are recognized and classified as measurement scales. These are nominal, ordinal, interval and ratio scales. The nominal scale assigns values to an object for identification or classification only, for example male or female. Beyond classification the ordinal scale enables ranking of objects or responses, for example good, better, best. Interval scale has both nominal and ordinal properties but also capture information about differences in quantities of a concept from one observation to the next. Last is ratio scale which beyond having the properties of the other three scales already discussed, measures variables that have a natural zero point.

Data collected in this study is of nominal and ordinal nature. The dependent variable is the adoption of CSPT among tea factories run by KTDA in Kenya. Adoption of CSPT is a dichotomous concept, meaning a factory will either have adopted CSPT or not. The measurement at every factory was therefore classified either as ‘adopted CSPT or not adopted CSPT’, or ‘installed CSPT or not installed CSPT’. This variable therefore bears nominal data and a nominal scale was applied. A nominal scale assigns a value to an object for identification or classification only. It involves collecting information on a variable that can be grouped into two or more categories that are mutually exclusive and collectively exhaustive (Cooper & Shindler, 2011). The independent variables were awareness creation, CSPT attributes, organization complexity, access to credit and CSPT standardization. For inference purpose it was important to measure the respondents’ views on the importance of the individual independent variables in influencing the decision to adopt CSPT. To enable this, the method of summated ratings, developed by Rensis Likert (Zikmund, 2013) was adopted. This is a measure of attitudes designed to allow respondents rate how strongly they agree or disagree with carefully constructed statements ranging from very positive to very negative attitude towards a specific aspect. These summated ratings bear ordinal data. Ordinal scale was therefore applied in measuring the five independent variables. This measurement scale is useful for managers when the organization plans to undertake a program of change or improvement (Cooper & Shindler, 2006). The operationalization and measurement scales for the study is detailed in table 3.1.

3.9 Data Analysis and Presentation

Data analysis is the application of reasoning to understand the data that has been gathered (Zikmund et al, 2013). It involves application of statistical techniques to the data that has been collected to get a feel for the data, testing the goodness of data, and for testing hypotheses developed for research (Bryman, 2012; Sekaran, 2010). For this study, data analysis commenced with data processing involving the stages of data editing and coding. Data editing is the process of checking the completeness, consistency and legitimacy of data, making the data ready for coding and storage. Coding on the other hand involves assignment of numerical scores or classifying symbols to previously edited data to give meaning to the data.

The next stage was descriptive analysis. This is the elementary transformation of data in a way that describes the basic characteristics of the subjects such as central tendency, distribution, and variability (Sekaran, 2010). The results have been presented in form of tables and figures in the next chapter. These are accompanied by prose interpretations of the data.

Table 3.1: CSPT Adoption Variables and their Measurement Scales

Variable	Variable Type	Measurement Scale	Parameters
Adoption of CSPT	Dependent	Nominal	- Adopted CSPT - Not adopted CSPT
CSPT attributes	Independent	Ordinal	- Cost effective - Carbon emission - No health hazard - 24 hour availability - Heat range - Ease of installation - Triability
Awareness creation	Independent	Ordinal	- Brochures - Posters - Resource books - Public presentations - Public workshops - Exhibitions & trade shows - Newspaper advertising - Magazines advertising - Electronic publications
Organization complexity	Independent	Ordinal	- On-the-job training - Overseas training - Formal training - Informal training - University training - VETI Training
Access to finance	Independent	Ordinal	- Capital reserves - Credit facilities - Cost of credit - Collateral requirement - Grants government - Grants devpt. partners - Subsidies - Tax credits - Venture Capital funding - Public Private Partnerships - Insurance schemes
CSPT Standardization	Independent	Ordinal	- Quality assurance - Installation procedures - KEBS marks of quality - ISO certification - KEREA accreditation

The last analysis stage was inferential analysis of the independent variables and the dependent variable. This was an effort seeking to identify the extent to which each independent variable under study was likely to influence the adoption of CSPT among the KTDA managed tea factories. To accomplish this, a binary logistic regression analysis was identified to generate a model on the likelihood of various indicator variables to influence the adoption of CSPT technologies in the tea factories in Kenya. Logistic regression determines the impact of multiple independent variables presented simultaneously to predict membership of one or other of the two dependent variable categories (Menard, 2002; Gujarati & Porter, 2009). It is used instead of linear regression which has the crucial limitation that it cannot deal with dependent variables that are dichotomous and categorical. The two dependent variable categories in this study are adopted CSPT and not adopted CSPT.

The goal of logistic regression is to find the best fitting model to describe the relationship between the dichotomous characteristic of interest (dependent variable) and a set of independent variables (Menard, 2002; Gujarati & Porter, 2009). Logistic regression generates the coefficients of a formula to predict a logit transformation of the probability of presence of the characteristic of interest, expressed as follows:

$$\boldsymbol{Logit(p) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \ldots\ldots + \beta_k X_k} \qquad \textbf{(i)}$$

where p is the probability of presence of the characteristic of interest. The $\beta_0, \beta_1, \beta_2, \ldots\beta_k$ are the logistic regression coefficients of the equation. They are used to predict the change in the probability of the dependent variable taking the category of interest due to a one-unit change in a specific independent variable. This is accomplished by using the coefficients to compute the odd ratio. The odds ratio is equal to exp(*b*), sometimes written as e^b. Substituting the exponent constant (about 2.72) and raising it to the power of *b*, we get the odds ratio. For example, if the regression coefficient of an independent variable is 0.75, the odds ratio is $.75^{(2.72)}$ which is approximately 2.12. This would be interpreted to mean that a change of the independent variable by one unit increases the likely hood of the dependent variable assuming the desired category by 2.12 times, holding all other independent variables constant.

For this study the logistic regression model is developed by letting Y = CSPT adoption, where Y is a binary variable such that Y = 1 if the CSPT is adopted and Y = 0 if CSPT is not adopted. The logistic regression equation for the study will be as follows:

$$\boldsymbol{logit(p) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5} \qquad \textbf{(ii)}$$

Where p = probability of a tea factory adopting CSPT

X_1 = Attributes of CSPT

X_2= Awareness of CSPT

X_3 = Access to Finance.

X_4 = Organization complexity

X_5 = Standardization of CSPT

$\beta_1 \ldots \beta_5$ are logistic regression coefficients which express the relationship between the CSPT adoption and the respective independent variables.

Nevertheless, findings from the pilot test suggested adoption of CSPT by the tea factories was a rare event. This was because out of the four tea factories investigated in the pilot, none of them had adopted CSPT. When full data collection exercise was completed only three factories were found to be in the process of CSPT adoption. The three had gathered intelligence on CSPT and made the decision to adopted CSPT. They were in the evaluation stage of alternative providers and financing mechanisms. This meant that the data collected for the study was a rare event data. Rare event data consists of binary dependent variables with thousands of times fewer *ones* (desired event) than *zeros* (undesired event) (Allison, 2012). The desired event in this study was 'factory adopted CSPT' and the undesired event was 'factory not adopted CSPT'.

Standard logistic regression explained above, which was targeted for inferential analysis in this study, arrives at maximum likelihood estimates (MLE) of the relationship between the dependent variable and the indicator variables. However, MLE algorithms analysis breaks down when rare event data is run (Allison, 2012; Rasch & Waibel, 2013; Shen & Gao, 2008). This is firstly attributed to multicollinearity. This is the singularity of the design matrix. Secondly failure is caused by occurrence of complete or quasi separation. This is where linear combination of predicator variables perfectly predict the outcome, in which MLE does not exist. This is common in binomial regression with binary predictors and more common in unbalanced data or where absolute rareness occurs. This was the case of this study's data.

Fortunately statistical remedies exist for such a situation. There are sampling techniques and special algorithms for dealing with rare events data. One such technique is under-sampling, which involves reducing the number of observations from the dominant category to make data more balanced (He & Garcia, 2009). Considering the rare observations of CSPT adoption among tea factories, under-sampling would not have been of use. Another technique is over-sampling which involves increasing the observations of the minority category to balance the data. This can be done randomly or through generation of synthetic data. Over-sampling may result in over-fitting in some algorithms (since it involves duplication of data) but it does not do so in logistic regression (Paal, 2014; Altini, 2015). Over sampling only shifts the intercept but does not affect the slope (parameter estimates). Oversampling was applied in this study to improve on CSPT adoption category. Systematic duplication of every 20th observation, beginning with the 6th observation, was done with CSPT adoption assuming the value 1. This resulted in an additional four observation units, giving a total of seven adoption category cases. This effectively made the data a complex data set.

A complex data set from a survey is one that is arrived at through complex sampling methods such as stratification, oversampling and multistage sampling, whereby observations have an unequal probability of selection (Nielson & Seay, 2014). This kind of data should not be analysed the same way as data arrived at through random sampling. Doing so increases the probability of a type I error. Two approaches are commonly used to deal with the analysis of complex data sets. The first is complex sample logistic regression which caters for complex samples but does not deal with separation and quasi separation problem. Thus attempt to use this approach resulted in results that are unreliable. The alternative is to use penalized maximum likelihood algorithms such as Ridge, Lasso and Firth.

Penalized logistic regression (PLR) is a variation of logistic regression developed to take care of the complete and quasi-separation complications that arise when analysing complex data using standard logistic regression and maximum likelihood estimation (MLE) (Fijorek & Sokolowski, 2012: Allison, 2012). The procedure yields finite estimates of parameters under complete or quasi-complete separation. It has farther been proved to largely reduce the small sample bias of MLE estimates (Fijorek & Sokolowski, 2012). 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). Owing to this choice, the studies earlier standard regression model expressed in equation (ii) is modified to reflect the firth model expressed in equation (iii).

$$\textbf{\textit{Logistf}}\ \textbf{(}\textbf{\textit{CSPT Adoption}}\textbf{)} = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 \qquad \textbf{(iii)}$$

Firth penalized logistic regression modelling was done for each of the objectives. To evaluate model fit McFadden R^2 statistic was used. McFadden R^2 statistic measures the predictive power of a model. It measures how well one can predict the independent variable using the independent variables. McFadden suggested a model with McFadden R^2 statistic of between 0.2 and 0.4 exhibits an excellent fit (Cole, Chu, & Greenland, 2013). The statistical significance of the model and individual regression coefficients were tested using the p value (based on likelihood ratio chi-square). The test is applied when a variable under observation is categorical, and is used to determine whether data collected are consistent with a hypothesized distribution (Johnson, 2017). A significance level threshold of 0.05 was set for testing hypotheses. A combination of IBM SPSS statistics 23 and STATISTICA 12 softwares were used to generate the above statistics. The outcomes of the analysis are presented in form of tables and figures in the next chapter.

The first independent variable was attributes of CSPT. It was regressed against adoption of CSPT using its elements (cost effectiveness, health friendly, twenty four availability, easy to install, within acceptable heat range, minimize carbon emissions and triability) as covariates. The model for CSPT attributes was expressed as:

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

$$= \boldsymbol{\beta + \beta_1 Costef + \beta_2 Hhzd + \beta_3 Twty4h + \beta_4 EasyIn + \beta_5 Hrange + \beta_6 MinCarb + \beta_7 Triabl} \qquad \textbf{(iv)}$$

Where β = is constant level of adoption not influenced by the regressor, X_1 = CSPT attributes, $\beta_1 \ldots . \beta_7$ are regression parameters, while Costef, Hhzd, Twty4h, EasyIn, Hrange, MinCarb and Triabl are abbreviations for attributes of CSPT predictors cost effective, healthy, twenty four hours, easy to install, acceptable heat range, minimize carbon emissions and triability respectively.

The second predictor variable was CSPT awareness. Predictors of CSPT under awareness were use of brochures, posters, resource books, public presentations, public workshops, exhibitions, newspaper advertisements, magazine advertisements, and electronic publications. The model for CSPT awareness was expressed as:

$$\text{logist}f\,(\text{CSPT Adoption}) = \beta + \beta_2 X_2$$

$$= \boldsymbol{\beta + \beta_1 Broch + \beta_2 Posters + \beta_3 ResBks + \beta_4 PublP + \beta_5 Wkshop + \beta_6 Exhb + \beta_7 NewsP + \beta_8 Mag + \beta_9 ElectP} \qquad \textbf{(v)}$$

Where β = is constant level of adoption not influenced by the regressor, X_2 = CSPT awareness, β_1…..β_6 are regression parameters, while Broch, Posters, ResBks, PublP, Wkshop, Exhb, NewsP, Mag, and ElectP are abbreviations for awareness of the awareness creation approaches CSPT predictors brochures, posters, resource books, public presentations, workshops, exhibitions, newspaper advertising, magazine advertising, and electronic publications respectively.

The third independent variable was organization complexity as a predictor of CSPT adoption. The organization complexity factors investigated that would influence adoption of CSPT were management skills, technician skills, engineering training, technician training, and education levels. Beyond these, training delivery modes that would influence adoption of CSPT were also investigated and these were on-the-job training, overseas training, formal education programs, informal education programs, training & networking with universities, and training &networking with vocational education training institutions (VETIs). The model for organization complexity was as follows:

Logist*f* (CSPT Adoption) = $\beta + \beta_3 X_3$

$$= \boldsymbol{\beta + \beta_1 OnJob + \beta_2 Ovseas + \beta_3 Formal + \beta_4 Informal + \beta_5 UniversTr + \beta_6 VocITr} \qquad \textbf{(vi)}$$

Where β = is constant level of adoption not influenced by the regressor, X_3 = organizational structure characteristics, $\beta_1 \ldots \beta_9$ are regression parameters, while OnJob, Ovseas, Formal, Informal, UniversTr, and VocITr are abbreviations for organization complexity predictors on-the-job training, overseas training, formal education programs, informal education programs, training &networking with universities, and training &networking with VETIs respectively.

Another independent variable was access to finance. Subset variables were capital reserves, access to credit, cost of credit, collateral, grants, subsidies, tax credits, venture capital, public private partnerships, and insurance. Model developed for access to finance was as follows:

Logist*f* (CSPT Adoption) = $\beta + \beta_4 X_4$

$$= \boldsymbol{\beta + \beta_1 CostC + \beta_2 AcessC + \beta_3 CostCap + \beta_4 Colat + \beta_5 GrntG + \beta_6 GrntD + \beta_7 Subsd + \beta_8 TaxC + \beta_9 VentC + \beta_{10} Ppp + \beta_{11} Insur} \qquad \textbf{(vii)}$$

Where β = is constant level of adoption not influenced by the regressor, X_4 = access to finance, $\beta_1 \ldots \beta_{10}$ are regression parameters, while CostC, AcessC, CostCap, Colat, GrntG, GrntD, Subsd, TaxC, VentC, Ppp, and Insur are access to finance predictors capital reserves, access to credit, cost of credit, collateral, grants from government, grants from development partners, subsidies, tax credits, venture capital, public private partnerships, and insurance schemes respectively.

The last dependent variable was CSPT technology standardization. Important dimensions of this variable were quality assurance, standard installation procedures, KEBS mark, ISO standard, and KEREA accreditation. These developed into the following model:

Logist*f* (CSPT Adoption) = $\beta + \beta_5 X_5$

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

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

The combined effect of CSPT attributes, CSPT awareness, organizational structure characteristics, access to credit and CSPT technology standardization on CSPT adoption is represented as an aggregate of the above models. This is presented below:

Logistf **(*CSPT Adoption*) =** $\boldsymbol{\beta_0 + \beta_1}$**CSPT Attributes +** $\boldsymbol{\beta_2}$**CSPT Awareness +** $\boldsymbol{\beta_3}$ **Organization Complexity +** $\boldsymbol{\beta_4}$ **Access to Finance +** $\boldsymbol{\beta_5}$**CSPT Standardization (ix)**

Where $\beta_1 \ldots \beta_5$ are logistic regression coefficients which express the relationship between the CSPT adoption and the respective independent variables.

3.10 Chapter Summary

This chapter details the key foundations and procedures of this study. It first clarified the research philosophy of positivism the study is aligned to. Then research design, target population and data collection tools and procedures of the study were outlined. This was followed by discussions of pilot study results, variables measurement characteristics and, data analysis procedures and expected resultant models on likelihood of adoption of CSPT by tea factories tea factories managed by KTDA.

CHAPTER FOUR

RESEARCH FINDINGS AND DISCUSSIONS

4.1 Introduction

This study focused on the determinants of the likelihood of the adoption of CSPT among tea factories managed by KTDA in Kenya. This chapter first presents a descriptive analysis of the study findings followed by an inferential analysis of factors likely to influence the adoption of CSPT by factories managed by KTDA. The descriptive analysis covers the response rate, profiles of the KTDA factories and their managers, and the KTDA factory's heat energy uses and sources. The inferential analysis section details results of the regression procedures followed by tests of hypotheses in line with the objectives of the study.

4.2 Response Rate

This study was a census survey targeting all sixty six (66) tea factories in Kenya managed by KTDA. The researcher was able to get to all the 66 factories and got satisfactory responses from the factory managers. A response rate of 100% was therefore attained. This is attributed mainly to the clear structure of the industry and factory managers who were generally highly available and engrossed in factory operations on a daily basis. Prior contact and appointments scheduling also played a role in attaining the response rate.

4.2.1 Respondents and Factory Characteristics

A number of characteristics were investigated at the tea factories. These were the managers' age and job experience, factory energy uses and sources, and the challenges the factories are experiencing with their current source of energy heat. These characteristics are briefly discussed below.

4.2.2 Factory Managers Age

The targeted respondents in the study were the 66 factory unit managers. The managers were classified in respect to their age group. Most of the managers (80.3%) were in the 41-50 years age bracket while 15.2% were above 50 years and 4.5% in the 31-40 years range. None of the managers was below 30 years old. This can be attributed to the fact that to get to the top manager level, one may be required to have substantial experience in the industry which one may hardly get before 30 years of age. This age structure is detailed in Table 4.1.

Table 4.1: Distribution of Factory Manager's Age

	Frequency	Percent
Below 30 years	0	0
31-40 years	3	4.5
41-50 years	53	80.3
over 50 years	10	15.2
Total	**66**	**100.0**

4.2.3 Factory Manager's Experience

Another characteristic of the tea factory managers captured was their managerial experience, in years, working at tea factories. The bulk of the managers (68.2%) had over ten years of experience while the balance (31.8%) had an experience of between six and ten years. None of the managers had an experience in the range of five years or less. This depicts management profiles with profound experience in tea processing, and would therefore be in a position to give credible information on the tea sub-sector. This manager's experience data is illustrated in Table 4.2.

Table 4.2: Distribution of Factory Manager's Experience

	Frequency	Percent
0 – 5 years	0	0
6 - 10 years	21	31.8
over 10 years	45	68.2
Total	**66**	**100.0**

4.2.4 Factory Heat Energy Uses and Sources

The study investigated the heat energy uses and sources of heat energy of the target factories. The factories had two utilizations of heat energy, namely withering and drying. Each of these functions consumed over 15% of the factory energy resource. The factories had three sources of heat energy. These were fuel wood, fuel oil and briquettes. Sixty five (65) of the factories (98.48%) were using fuel wood as the only source of energy heat but kept a small strategic reserve of fuel oil, just in case of need. One of the factories was using briquettes (made from biomass) 100% but also key a minimal stock of fuel oil as a precaution. These results are illustrated in Table 4.3.

Table 4.3: Factory Sources of Heat Energy

Usage Percentage	Source of Heat Energy		
	Fuel wood	Briquettes	Fuel oil
Below 5%	1	65	66
5 – 10 %	0	0	0
11 – 20 %	0	0	0
21 – 40 %	0	0	0
41 – 60 %	0	0	0
61 – 80 %	0	0	0
Over 80%	65	1	0

The above result indicates that none of the factories run by KTDA were making use of the CSPT technology. In fact none of the factories was making use of any solar technology in their tea processing.

4.2.5 Challenges of Current Sources of Energy Heat

The respondents were requested to identify the key challenges they experienced from using their current source of heat energy. The challenges identified were high prices of the energy source, volatility of energy source price, pollution by the energy source (carbon emissions), depletion of source of energy, health hazard caused by the source of energy, intermittence of the source and being messy. The threat of depletion of the energy source was ranked as the number one challenge of the current energy source. It attained a mean score of 4.48 out of a possible 5, with 50% of the respondents describing it to be a challenge to a high extent, and 46% considered it to be a challenge to a very high extent. This was followed by high prices of the energy source with a score of 4.36 from the respondents, and with 64% and 36% describing it as a challenge to a high extent and to a very high extent respectively. The current source of energy being polluting and being a health hazard followed with scores of 3.64 and 3.47 respectively. The challenges of volatile price, being intermittent and being messy were scored 2.79, 2.65 and 2.38 in that order. These responses are illustrated in Table 4.4.

Table 4.4: Challenges of Current Sources of Energy heat

Factor	Percentage					Mean	Std. Dev
	Not at All	Small Extent	Moderate Extent	High Extent	Very High Extent		
High prices	0	0	0	64	36	4.36	0.485
Volatile price	2	6	44	18	0	2.79	0.755
Polluting	6	35	48	11	0	3.64	0.757
Getting depleted	0	2	2	50	46	4.48	0.561
Negative health	0	11	33	54	2	3.47	0.706
Intermittent	0	48	38	14	0	2.65	0.712
Messy	8	48	42	2	0	2.38	0.651
Average						**3.39**	**2.52**

The above challenges identified by the respondents are a good pointer to the potential of CSPT in tea processing. The first ranked challenge of the sources of energy getting depleted gets an outright remedy from CSPT. This is because CSPT is energy from the sun which is abundant in Kenya and has no known limit. It is non-depletable and renewable source of energy. Though the prices of CSPT technologies have generally been high (in the last decade), evidence is there that its prices have come down tremendously and going forward will have an edge against most other sources of heat energy. On the aspects of pollution and health hazard, CSPT is one of the energy sources labelled as 'clean energy' that particularly reduce carbon emissions of industrial processes (IRENA, 2015). It cannot be compared with the fossil fuels, biomass or even some renewables sources such as briquettes that some of the factories are using. Kenya is within the tropics ensuring sunlight availability throughout the year, thereby overcoming the intermittence challenge. Overall CSPT fairly circumvents the challenges cited by the respondents on their current sources of heat energy.

4.3 Adoption of CSPT by Tea Factories

As explained earlier in chapter two, adoption is a process involving five stages. These are knowledge, persuasion, decision, implementation and confirmation stages. The managers were asked to indicate at what stage their respective factories were in in the adoption process. Sixty of the factories (91%) strongly agreed that their factories had not made any move towards the adoption of CSPT process. They were not aware of any CSPT information in the industry. This was an acknowledgement that of over ninety percent of the factories had not started on the CSPT adoption process, a stage that is describe as Prior. The other six of the factory managers were aware of the CSPT technology, and actually three of them (4.5%) had made a decision to adopt the CSPT technology. However, they had not implemented the decision. They were still in the procurement logistics. The other three of the factories were aware of the technology, its benefits and possible challenges. They were still evaluating the option of adopting but had not made the decision. These results are illustrated in Table 4.5.

Table 4.5: 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**

The above distribution of the tea factories in accordance with their CSPT adoption status was tested for normalcy. This was by testing for skewness and kurtosis of the data. Skewness is a measure of data asymmetry with the normal distribution having a skewness value of zero (Hippel, 2010). A data distribution with skewness value two times or more of the skewness standard error is considered asymmetric, and therefore not normal. Skewness value for the CSPT adoption by tea factories status data was calculated at 2.809, with a standard error of 0.295. This skewness value is almost ten times its standard error and therefore implies that the distribution of data on CSPT adoption status of the tea factories is not normally distributed. Kurtosis is a reference of the extent to which observations cluster around a central point. For a normal distribution kurtosis is scored at zero. Any significant departure from this score reflects a distribution that is not normal. The data on factory CSPT adoption status was scored at 6.9. This finding supports the skewness measure results for a conclusion that the factory CSPT adoption status data is not normally distributed. These findings are illustrated in Table 4.6.

Table 4.6: 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 data distribution was also assessed using a Q-Q plot (quantile-quantile plot). This is a graphical tool used to test whether a data set is normally distributed. It is preferred because it shows at a glance if normality assumption is plausible. A normal distribution will usually result in a straight line plot, and a curved plot indicates data that is not normally distributed. The Q-Q plot for the factory CSPT adoption status data is illustrated in Figure 4.1 below. The observed values plots are way off the normal distribution expected plot, again confirming the factory CSPT adoption status data is not normally distributed.

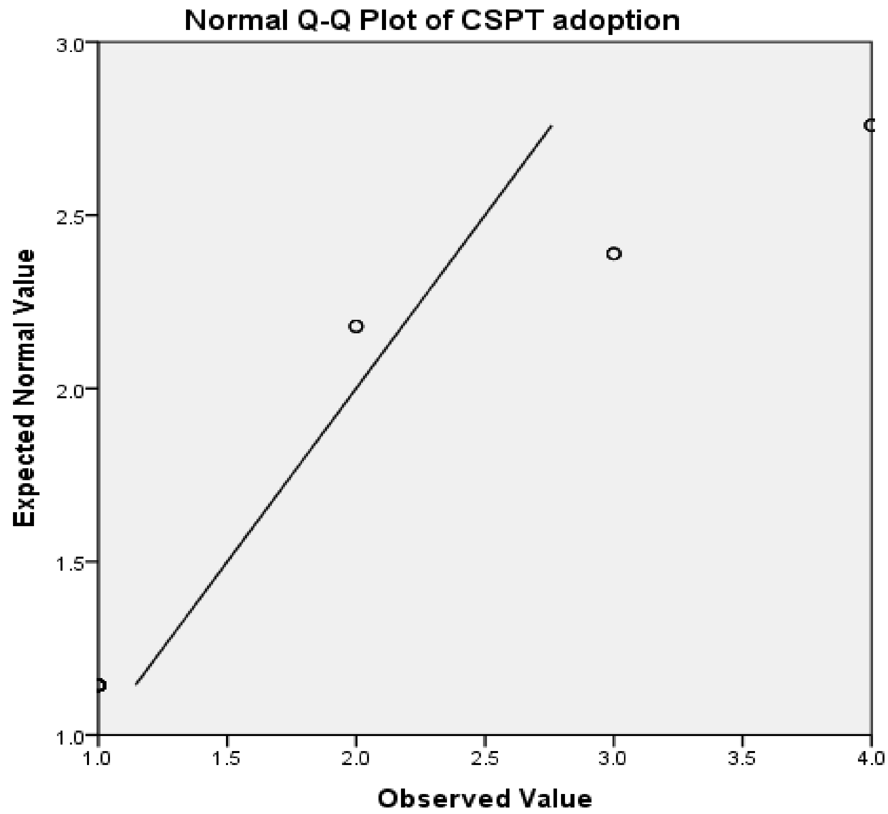

Figure 4.1 Factory CSPT Adoption Status Q-Q Plot

4.4 Attributes and Likelihood of CSPT Adoption

The first objective of this study focused on the likelihood of CSPT attributes to influence the adoption of CSPT technology among tea factories managed by KTDA. These attributes were cost of CSPT, minimizing carbon emissions, minimizing health hazard, being a twenty four hour source, being within required heat range, being easy to install, and being triable.

4.4.1 Descriptive Statistics of Product Attributes

Responses on each of the product attributes on their likelihood to influence the adoption of CSPT are detailed in Table 4.6 below. All the six attributes scored between 4 and 5 (out of 5), which is quite high. The most preferred attribute by the respondents, which would most likely influence adoption of CSPT, was 'being in the required energy range' of the factory. The tea factories require heat energy of a maximum 100^0C for drying or withering. This attribute attained a mean score of 4.62, with 62% factory managers strongly agreeing and 38% agreeing that it can enhance adoption of CSPT. This is a 100% agreement. It was followed by 'being a twenty four hour source' with a mean of 4.61. This is the advantage of CSPT being available day and night through sunlight during the day, and stored solar energy at night. This attribute had a 61% strongly agree and 39% agree ratings on its likelihood to influence the adoption CSPT. The third ranked attribute was 'being cost effective' with a mean score of 4.47. This is the potential of CSPT being cheaper than current sources of heat energy for the tea factories, namely wood fuel and fuel oil. This attribute attained a 43% strongly agree and 57% agree ratings from the managers.

Beyond these three attributes the other four attributes also scored high mean scores of over 4.2. 'Being easy to install' had a mean of 4.37, with 50% strongly agree and 50% agree ratings. The attribute 'minimize carbon emissions' scored 4.36, with 36% strongly agree and 64% agree ratings. Ability to 'minimize health hazards' had a mean score of 4.29 with strongly agree approval of 29% and 71% agreeing. The last one was 'being triable before purchase' with a mean score of 4.24 and 24% strongly agree and 76% agree ratings. The average of the mean scores is 4.44 (out of 5) with a standard deviation of 0.182. This is an indication that of all the attributes were considered important and likely to influence CSPT adoption by the respondents. The standard deviation implies that the distribution of responses cluster around 4.44 with lowest possible score of 4.258 and highest possible score of 4.622. As mentioned earlier CSPT is environmental friendly, poses no health hazards to workers, and its cost regime has been plummeting and is therefore very promising. It therefore seems CSPT has most of the attributes that respondents claimed would make them make an adoption decision.

Table 4.6: Descriptive Statistics of CSPT attributes

CSPT Attribute	Percentage					Mean	Std. Dev
	SD	D	DK	A	SA		
More cost effective	0	0	0	53	47	4.47	0.503
Minimizes carbon emissions	0	0	0	64	36	4.36	0.485
Minimizes health hazards to employees	0	0	0	71	29	4.29	0.456
Is a twenty four hour source of heat energy	0	0	0	39	61	4.61	0.492
Heat energy in the range requirement of the factory	0	0	0	38	62	4.62	0.489
Is easy to install	0	0	0	50	50	4.50	0.504
Triable before purchase	0	0	0	76	24	4.24	0.432
Average						**4.44**	**0.182**

4.4.2 Inferential Statistics of Product Attributes and CSPT Adoption

The first objective of this study was to assess the likelihood of CSPT attributes to influence the adoption of CSPT by the Kenyan tea factories run by KTDA. To enable measurement as to whether CSPT attributes can influence CSPT adoption among the tea factories, a hypothesis was derived that would be tested using the findings of the field study. The hypothesis was:

$H_0$1: There is no significant relationship between CSPT attributes and likelihood of adoption of CSPT among the Kenyan tea factories run by KTDA.

To test the hypothesis for the influence of all the attributes on CSPT adoption, the product attributes data and CSPT adoption data were fitted in a Firth logistic regression model. The results of the regression are detailed in Table 4.7.

Table 4.7: Model CSPT adoption and CSPT attributes Statistics

Model: Firth Logistic regression (logitf) (Attributes.sav1.saved)

Penalized log likelihood = -18.984802 Prob> chi^2 = 0.0330

McFadden R^2=0.4135

	Constant B_0	**Cost Effect**	**Minim Carbon**	**No Health Hazard**	**Twenty Hour hr.**	**Heat Range**	**Easy to Install**	**Triable**
Estimate	-3.8947	1.6837	0.4788	1.2464	1.9800	1.0119	0.3358	**0.6554**
p-value	0.5212	0.0483	0.0375	0.04028	0.0333	0.03175	0.07359	**0.04083**
Odds ratio	0.0203	5.3854	1.6141	3.4778	7.2430	2.7508	0.7147	**1.9260**

The model attained R^2 of 0.4135 of the McFaddens' R^2 static of model fitness. This was slightly off the perfect fit of between 0.2 and 0.4, meaning the model slightly over-fits. This measures how well the model can be used to predict CSPT adoption from the attributes. In this case the model slightly exaggerates the Adoption likelihood. The model was statistically significant with a Chi^2 score of 0.0330, which is lower than the 0.05 threshold. This implies that the model of the dependent variable and the covariates explains the likelihood of the adoption of CSPT better than a model with only the intercept at a confidence level of 95%. This conclusion leads to the rejection of the hypothesis to the first study objective which stated that 'There is no significant relationship between CSPT attributes and likelihood of adoption of CSPT among the Kenyan tea factories run by

KTDA'. By implication then, according to the findings of this study the seven CSPT attribute considered together have a likelihood of influencing adoption of CSPT by tea factories in Kenya.

The other output of the analysis is parameter estimates (regression coefficients) of each independent variable in the model. These parameters show extent to which a change in a predictor variable would influence the response variable when all the other predictor variables are in play. The attribute 'being a twenty four hour source' had the highest coefficient of 1.98 followed by 'being cost effective' with 1.68, and the third was 'minimizing health hazard' with 1.25. These three attributes can therefore be considered to be the ones likely to influence adoption of CSPT most. The other attributes would be less influential with 'being in the energy heat range' at 1.012, 'being triable' at 0.655, and 'minimize carbon emissions' at 0.488. The last one, 'easy to install' has a negative coefficient suggesting its contribution to adoption might be negative.

Further, the significance of each of the attributes in the model were calculated at 0.05 level of significance. Six of the attributes had p-values of less than 0.05, meaning they were statistically significant. These were 'cost effective' at 0.0483, 'minimize carbon emission' 0.0375, 'no health hazard' at 0.040, 'twenty four source' at 0.0333, 'being within heat range' at 0.03175 and ' being triable' at 0.04083. All these six attributes were found to be significant at 95% confidence level. The last attribute 'being easy to install', had a p-value score of 0.07359, which exceeds the 0.5 threshold. It is therefore not statistically significant which means it cannot be expected to influence the adoption of CSPT at 95% confidence level. This particular attribute will therefore be excluded from the model. The model earlier expressed in equation (iv) now crystalizes to equation (x) below.

Logist*f* (CSPT Adoption) = -3.8947 + 1.684Costef + 1.246Hhzd + 1.98Twty4h+1.012Hrange + 0.479MinCarb +0.6554Triabl (x)

Odd ratios for each of the attributes were calculated. Odd ratio shows the extent to which a predictor variable can change the response variable when the predictor variable is changed by one unit, all the other factors remaining constant. The ratios, therefore, indicate the likely change in the dependent variable occasioned by variance of each independent variable considered alone. In this respect the highest odd ratio was that of the 'being twenty four hour source' attribute at 7.24. This means that if any contribution in making the CSPT a twenty four hour source is likely to cause a rise in adoption of CSPT by over seven times. The second attribute in this respect was 'being cost effective' at 5.385, while the third was 'no health hazard' at 3.478. These three are the attributes that are individually likely to spur higher adoption of CSPT among tea factories managed by KTDA. 'Being within heat range', 'being triable' and 'minimize carbon emissions' also are likely to have significant influence on CSPT adoption with their respective odd ratios of 2.75, 1.926, and 1.614. 'Being easy to install is likely to have the least influence with a ratio of 0.7147.

The above results show that CSPT attributes individually and severally are highly likely to influence adoption of CSPT among tea factories managed by KTDA. This assertion is based on the high mean scores (all over 4 out of 5) and significances of the covariates. This is in line with the emphasis by Rogers on the importance of product attributes in influencing adoption, claiming they account for 49% to 87% of adoption variance (Feng, 2012). Though specific product features were not cited in the empirical studies discussed earlier in this study, their importance was boldly underlined. In the two projects conducted in India on CSTs, product attributes were showcased in pilot demonstrations (on viability of

CSTs), case studies and success stories (Ocampo & Marthel, 2012; Akker& Aggarwal, 2015; UNDP, 2015). Further reports were prepared on the salient features of CSTs.

4.5 CSPT Awareness and CSPT Adoption

Focus of the second study objective was on CSPT awareness and its likelihood to enhance adoption of CSPT. The managers were investigated on their awareness of CSPT, its benefits over other sources of heat energy, its suppliers and the disadvantages of the factories current sources of heat energy. Further they gave their views on awareness techniques that are likely to influence the likelihood of adoption of CSPT among tea factories managed by KTDA.

4.5.1 Descriptive Statistics of CSPT Awareness.

The managers were first investigated on their awareness of CSPT itself, awareness of CSPT benefits over other sources of heat energy, awareness of CSPT suppliers and awareness the disadvantages of the factories current sources of heat energy (fuel-wood and fuel oil). Fifty nine percent of the respondents (59%) strongly disagreed that there is adequate information on CSPT in the industry, while 29% of them simply disagreed, making up a whopping 90% confirmation that there is no CSPT information in the tea sub-sector. The full response on this is captured in Table 4.8.

Table 4.8: Factory Managers General Awareness of CSPT of Current Sources of Energy.

Awareness Status	Percentage (%) SD	D	DK	A	SA	Mean	Std. Dev.
There is adequate information on CSPT among the KTDA factories management	59	29	2	10	0	1.64	0.955
The factory management is aware of the benefits of CSPT over other sources of heat energy	26	21	3	41	9	2.86	1.429
The factory management knows the suppliers of CSPT	62	28	5	5	0	1.52	0.789
The factory management is aware of the disadvantages of fuel-wood as sources of heat energy	0	0	0	67	33	4.36	0.482
The factory management is aware of the disadvantages of fuel-oil as sources of heat energy	0	0	0	68	32	4.33	0.475
Average						**2.942**	**0.806**

Most of the managers (90%) had no clue on the suppliers of CSPT, with 62% of them strongly disagreeing and 28% disagreeing to be aware of the suppliers respectively. A substantial proportion of the managers (47%) were aware of the benefits of CSPT while 50% answered to the contrary. All the managers (100%) averred that they were aware of the disadvantages of fuel-wood and fuel-oil as sources of heat energy.

It is apparent from the above results that CSPT awareness is a major concern if the tea factories were to adopt CSPT. Most of the managers agreed that they have little information on the technology, its suppliers and benefits. Over 92% of the managers either didn’t know whether there is any information of CSPT in the industry or outright averred there isn’t. This is, therefore, a challenge that would need to be addressed in any effort to influence adoption of CSPT among the tea factories. These scenario echoes findings of empirical reviews done earlier. Virtually all reports cited earlier cited lack of awareness as a prime deterrent to technology adoption (Ocampo & Marthel, 2012; IRENA, 2015; Akker & Aggarwal, 2015). Subsequently awareness creation was a key component in renewable energy technologies adoption promotion programs in UNDP/GEF projects in India, UNIDO project in Malaysia (Rawlins & Ashcroft, 2013; Ocampo & Marthel, 2012). Awareness creation would therefore be a key intervention to influence the adoption of CSPT among tea factories in Kenya.

Beyond these general awareness of CSPT aspects, the mangers responded to CSPT awareness creation approaches that would enhance the likelihood of CSPT adoption. These were use of brochures, use of posters, use of resource books, public presentations, public workshops, public exhibitions, newspaper advertisements, magazines advertisements and electronic publications. Their responses were analysed using a summary of their mean scores and percentages presented in Table 4.9. Eight of the approaches had a score between 4 and five. These were use of brochures, public presentations, public workshops, exhibitions, resource books, newspapers, magazines and electronic publications. These were therefore the most preferred awareness creation approaches by the factory managers.

These findings highly resonate with reports on approaches recommended and used in other parts of the world. In the UNDP/GEF project in India 40 workshops on CSTs were conducted and several video films on successful CST projects placed on websites (Akker & Aggarwal, 2015). A monthly newsletter and a quarterly magazine on CSTs, SUNFOCUS, was developed and distributed to stakeholders. Advertisements on CSTs were released on national newspapers. A new website www.chindia.in was developed and together with the ministry websites made available information on CSTs suitability, costs and payback. In another project in south India by UNDP and GEF promoting use of renewable energy technologies newsletters, public presentations (in form of films, seminars and meetings), websites and exhibitions were used to create awareness among stakeholders (Ocampo & Maithel, 2012). Most of the awareness creation approaches preferred by the tea factory managers under KTDA were the ones utilized in the above described projects, except for use of a toll-free telephone line, and foreign tours, which were not investigated in this study.

Table 4.9: Awareness Creation Approaches

Awareness Creation Approach	Percentage SD	D	DK	A	SA	Mean	Std. Dev
Awareness through brochures influenced/will influence factory to adopt CSPT	0	0	0	88	12	4.12	0.329
Awareness through posters influenced/will influence factory to adopt CSPT	0	14	15	64	7	3.65	0.813
Awareness through resource books influenced/will influence factory to adopt CSPT	0	0	32	64	4	4.12	0.373
Awareness through Public presentations influenced/ will influence factory to adopt CSPT	0	2	17	72	9	4.03	0.554
Awareness through Public workshops influenced/ will influence factory to adopt CSPT	0	2	0	84	14	4.11	0.434
Awareness through Public Exhibitions influenced/will influence factory to adopt CSPT	0	0	0	80	20	4.20	0.401
Awareness through Advertisements in newspapers influenced/will influence factory top adopt CSPT	0	0	0	89	11	4.11	0.310
Awareness through Advertisements in magazines influenced/will influence factory top adopt CSPT	0	0	19	76	5	4.08	0.364
Awareness through Advertisements in electronic publications influenced will/influence factory top adopt CSPT	0	0	0	83	17	4.17	0.376
Average						**4.07**	**0.210**

4.5.2 Inferential Statistics of CSPT Awareness.

Second objective of the study was to find out the likelihood of CSPT awareness to influence the adoption of CSPT by tea factories managed by KTDA. To enable the analysis a hypothesis was formulated that would be tested using collected data, which was stated as follows:

$H_0$2: There is no significant relationship between CSPT awareness and likelihood of adoption of CSPT among the Kenyan tea factories run by KTDA

The manager's responses on awareness creation were fitted in a Firth logistic regression model whose key statistics are detailed in table 4.10.

Out of the nine awareness creation approaches investigated in the study on their likelihood to enhance the adoption of CSPT, five were found to be statistically significant, with p values of less than 0.05. These were 'use of brochures' with a p-value of 0.046, 'public workshops' with 0.0382, 'exhibitions' with 0.0328, 'newspaper advertising' with 0.0248 and 'electronic publications' with 0.0213. The others, 'posters' with p-value of 0.0501, 'resource books' with 0.0592, 'public presentations' with 0.06084 and 'magazine advertisements' with 0.0995 were found to be statistically insignificant at the 95% confidence level. This means that at the said level they may not influence the adoption of CSPT. The four variables will therefore be omitted from the model. The earlier model of CSPT awareness and the adoption of CSPT expressed by equation (v) is now modified as follows:

$$\mathbf{Logist}\boldsymbol{f}\mathbf{(CSPT\ Adoption) = -2.8930 + 0.255Broch + 1.057Wkshop + 1.485Exhb + 0.938NewsP + 1.118ElectP} \qquad \mathbf{(xi)}$$

Table 4.10: Model CSPT adoption and CSPT Awareness Statistics

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

Penalized log likelihood = -10.45802 Prob> chi^2 = 0.0482

McFadden R^2=0.2683

	Const. B_0	Brochures	Posters	Books	PublicP	PublicW	Exhibitions	Newspaper	Magazines	Electronic
Estimate	-2.8930	0.2546	0.3365	0.1720	-0.1876	1.0565	1.4846	0.9376	0.3074	1.1176
p-value		0.0460	0.0501	0.0592	0.6084	0.0382	0.0328	0.0248	0.0995	0.0213
Odds ratio		1.2899	1.4000	0.8419	0.8288	2.8762	4.4131	2.5538	1.3598	3.0575

The test of model fit was scored at 0.2683 McFaddenR^2, which is within the perfect fit range of 0.2-0.4 recommended by McFadden. It means the awareness creation variables in the model can be used to predict adoption of CSPT. On the model's statistical significance it had a Chi^2p-value score of 0.0482. This p-value is less than the 0.05 threshold, meaning the model is statistically significant at 95% confidence level. This indicates that at 95% confidence level there is a relationship between CSPT awareness and the adoption of CSPT by tea factories managed by KTDA. This leads to the rejection of the hypothesis to study objective two, which stated that 'There is no significant relationship between CSPT awareness and adoption of CSPT among the Kenyan tea factories run by KTDA'.

Odd ratios on the likelihood of each element of awareness to influence the adoption of CSPT were also calculated. The highest was that for exhibitions (4.4), which suggests that a change in exhibitions by one unit would increase the likelihood of CSPT adoption 4.4 times. The second one was electronic publication that would increase likelihood of adoption of CSPT 3.0575 times, and the third one was workshops with an odd ratio of 2.8762. The lowest were those of resource books and public presentations with odd ratios of 0.8419 and 0.8288 respectively. According to these results, to promote adoption of CSPT among tea factories managed by KTDA, a key intervention would be awareness creation. The key activities for this purpose in their order of importance would be exhibitions, electronic publications, workshops, newspaper advertising and brochures. The prime objectives of the awareness effort is to make CSPT and its benefits known to potential users, and to remove uncertainty (create confidence) in the new technology. These objectives are well served by the first three of the preferred awareness creation activities.

The above findings on awareness creation activities highly correspond to facts reported on empirical projects done in various parts of the world. First it corresponds to an observation by IRENA (an international organization involved in the promotion of use of sustainable energy) that most decision makers in industries do not have much information or first-hand experience with solar industrial process heat systems (IRENA, 2015). The organization concluded that this is one of the barriers that hinder adoption of the solar technologies, and therefore, recommended increased awareness and technical information transfer. The United Nations (UN) in its global action agenda to promote sustainable energy for all highlighted knowledge sharing as one of the enabling actions (IISD, 2014). This is recognition importance of awareness creation at the highest level.

In the UNDP/GEF project in India, which was very successful in promotion of use of energy reforms and renewable energy technologies by tea factories in south India, 35 seminars, 15 newsletters and over 30 demonstrations were used to promote awareness (Ocampo & Marthel, 2012). Still in India there is the UNDP/GEF project on promotion of use of CSH technologies. For awareness creation 40 workshops have been conducted, several video films uploaded on websites, a monthly newsletter and a quarterly magazine (SUNFOCUS) were launched, and advertisements released on national newspapers and magazines (Akker & Aggarwal, 2015). Further over 30 demonstration projects were conducted and exposure trips organized. Similar initiatives were reported in the UNIDO project in Malaysia where workshops, a website and case studies were used to hype up the need to adopt CSTs (Rawlins & Ashcroft, 2013). These initiatives are similar to the ones preferred by the KTDA tea factory managers except the seminars (public presentations) were not emphasized as in the empirical studies.

4.6 Organization Complexity and CSPT Adoption

The third study objective was to assess the likelihood of organization complexity spurring the adoption of CSPT. Complexity is the degree to which an organization's members possess a relatively high level of knowledge and expertise (Sahin, 2006). Tea factory manager’s views on their organizations complexity are presented next.

4.6.1 Descriptive Statistics on Organization Complexity

The factory managers gave their opinions on the technical capacity of their engineers and technicians for the installation and management of CSPT. The key aspects investigated were the education background of the engineers and technicians. All of the managers at least agreed the technicians and engineers they had, attained adequate level of education to enable CSPT installation and management training. Sixty nine percent (69%) of the managers felt the engineers and technicians in their factories had the requisite knowledge and skills for the management of CSPT. Thirty one percent (31%) of them either did not know or disagreed, which is a substantial proportion of the managers. The managers also fully agreed (by either strongly agreeing or simply agreeing) that there is need for specialized training of managers and technicians before the installation of CSPT in the tea factories. These results are captured in Tables 4.11.

Table 4.11: Factory Managers Response on Factory's Current Capacity Status

Current Capacity Status	Percentage (%) SD	D	DK	A	SA	Mean	Std. Dev.
Factory engineers had/have the knowledge to manage a CSPT facility	2	27	2	52	17	3.53	1.126
Factory engineers had/have the skills to install and manage a CSPT facility	2	27	2	52	17	3.53	1.126
Need for specialized training on CSPT installation for engineers before installation of a CSPT facility	0	0	0	30	70	4.70	0.463
Need for specialized training on CSPT operations for technicians before installation of a CSPT facility	0	0	0	29	71	4.71	0.456
Need for specialized training on CSPT maintenance for technicians before installation of a CSPT facility	0	0	0	32	68	4.68	0.469
Level of education of the engineers prepares them well for CSPT training	0	0	0	67	33	4.33	0.475
Level of education of the technicians prepares them well for CSPT training	0	0	0	68	32	4.32	0.469
Average						**4.257**	**0.271**

A reflection on the above results suggests a need for major knowledge and skills enhancement on CSPT for tea factory engineers and technicians to increase the likelihood of the factories adopting CSPT. This would be made easy by the presence of the requisite education levels. All the factory managers farther agreed there is need for technical training for technicians and managers in regard to CSPT installation, management and maintenance.

These findings echo recommendations and initiatives elsewhere targeting promotion of new energy technologies. In Nepal, lack of know-how in CSH systems has been blamed for lack of adoption of CSH systems in industries (Piya, Adhikari & Shreshtha, 2012). In their report (Piya et al, 2012) claim most industry players in Nepal have not heard of or seen CSH systems. IRENA in a technology brief on solar energy systems for industrial processes reported that there are few industry professionals with skills and experience on solar heat systems for industrial processes (IRENA, 2015). Therefore, IRENA posited that there is need for training and dissemination of existing knowledge and concepts on solar heat systems for industrial process heat.

A report on efforts to enhance transfer of aerospace technologies to NICs strongly emphasized that technical training is key in creating an absorption capacity for the new technologies (Heidena, Pohlb, Mansorc & Genderen, 2015). In the two UNDP/GEF projects in India mentioned earlier in this study, capacity building of technical staff was one of the key components in the programs to promote adoption of CSTs (Akker & Aggarwal, 2015; Ocampo & Marthel, 2012). Further, the UN in its SE4ALL (Sustainable Energy for All) initiative identified capacity building as the fourth enabling action in a framework to upscale use of renewable energies (IISD, 2014). All these are in agreement with the views of the respondents on the need for capacity building.

The managers also gave their opinion on the best training approaches to enhance the adoption of CSPT. The specific approaches addressed on their likelihood to enhance adoption of CSPT were on-the-job training, overseas training, formal education programs, informal education programs, net-works with universities, and net-works with vocational education institutes (VETIs). The mean scores of the various training approaches are shown in Table 4.12.

Table 4.12: Factory Managers Responses on Technical Training Approaches

Technical Training Approaches	**Percentage (%)**					**Mean**	**Std. Dev**
	SD	**D**	**DK**	**A**	**SA**		
On-the-job training will influence factory top adopt CSPT	0	0	0	86	14	4.14	0.346
Overseas training will influence factory top adopt CSPT	0	0	0	74	26	4.26	0.441
Formal education programs will influence factory top adopt CSPT	0	2	9	82	7	3.95	0.470
Informal education programs will influence factory top adopt CSPT	0	0	11	80	9	3.98	0.447
Training and networks with Universities Research institutions will influence factory to adopt CSPT	0	0	0	79	21	4.21	0.412
Training and networks with Vocational Education Training Institutions will influence factory to adopt CSPT	0	0	0	80	20	4.20	0.401
Average						**4.12**	**0.172**

The responses indicate that the most preferred training delivery methods as overseas training, training and networks with universities, training and networks with VETIs, and on-the-job training with each of them approved by a hundred percent of the factory managers (either by strongly agreeing or simply agreeing). However, overseas training comes out as the most preferred with 26% of the managers strongly agreeing, followed by training and networks with universities at 21% and training and networks with VETIs at 20%.

4.6.2 Inferential Statistics on Organization Complexity

The third hypothesis to this study was:

$H_0$3: There is no significant relationship between organization complexity and likelihood of adoption of CSPT among the Kenyan tea factories run by KTDA.

This hypothesis was to enable measure the third study objective which was to find out the likelihood of organizational complexity to influence adoption of CSPT. On subjecting the managers' responses to Firth logistic regression, only three of these approaches were found to be significant. These were 'overseas training', 'net-works with universities' and 'net-works with VETIs'. These results are detailed in Table 4.13.

Table 4.13: Technical Training Approaches and Adoption of CSPT

Model: Firth Logistic regression (logitf) N of 0's: 63 1's: 3
Penalized log likelihood = 3.06594 Prob> chi^2 = 0.01642
McFadden R^2=0.3177

	Const.B_0	On-the-job	Overseas	Formal	Informal	University	VETI
Estimate	-0.7138	-0.5570	2.7159	-0.7752	-0.9711	0.9603	1.2570
p-value		0.0704	0.0366	0.0634	0.0512	0.0325	0.0381
Odd Ratio		0.5729	15.1182	0.4606	0.3786	2.6124	3.3148

First, the model fit score attained was McFadden's R^2 of 0.3177. This falls within the McFadden acceptable range of perfect fit of 0.2-0.4. The model is therefore a powerful tool for estimating predicting adoption of CSPT among the tea factories managed by KTDA. Secondly, the model scored a Chi^2p-value of 0.01642. This score meets the 0.05 threshold for 95% confidence level. It implies that there is a significant relationship between organization complexity and the adoption of CSPT. This leads to the rejection of the third study hypothesis which stated that 'There is no significant relationship between organization complexity and adoption of CSPT among the Kenyan tea factories run by KTDA'.

Further, individual training methods statistical significance was tested and only three of the training methods scored p-values below 0.05. These were overseas training with a p-value of 0.0366, training and networks with universities with 0.0325, and training and networks with VETIs with 0.0381. The others (on-the-job with a p-value 0.0704, formal training with p-value of 0.0634, and informal training with p-value of 0.0512) scored p-values above 0.05 and therefore were not found to be statistically significant at 95% confidence level. These three were therefore removed from the initial model for organization complexity and the adoption of CSPT. The regression model of organization complexity likelihood to enhance the adoption of CSPT now changes from the earlier equation (vii) to the following:

Logist*f* (CSPT Adoption) = -0.7138+2.716Ovseas + 0.96UniversTr + 1.257VocITr
(xii)

The odd ratios for the different training methods were also computed and they give the training methods possibility of enhancing adoption of CSPT among tea factories if the training methods are individually varied by one unit (all other factors remaining constant). The odds reflect overseas training as the one more likely to increase adoption of CSPT with the highest ratio of 15.12. This means that an increase in overseas training by one unit would increase the likelihood of the adoption of CSPT 15.12 times. Training and networks with VETIs was second with an odd ratio of 3.315, while the training and networks with universities was the third with an odd ratio of 2.612. These three training approaches are the ones more likely to increase the likelihood of adoption of CSPT by tea factories managed by KTDA. The other three training methods had odd ratios less than one (on-the-job training with odd ratio of 0.5729, formal training with an odd ratio of 0.4606, and informal training with an odd ratio of 0.3786) and therefore their possibility of raising adoption of CSPT are much less.

Empirical studies highlighted earlier in these study all emphasize capacity building as a key intervention in endeavours to promote adoption of new technologies. The report on efforts to enhance transfer of aerospace technologies to NICs emphasized that technical training is key in creating an absorption capacity for the new technologies (Heidena, Pohlb, Mansorc & Genderen, 2015). Nevertheless, the report does not specify specific training delivery methods of preference. In the UNDP/GEF project in India promoting use of CSH technologies, component 2 of the project was on capacity building and emphasized manpower development of PhDs and Masters in the area of CSTs (Akker & Aggarwal, 2015). This corresponds with preference for training and networking with universities expressed by the KTDA managers. International trade tours were organized and a training centre on CSTs established at Brahma Kumaris (Singhal, 2015). These two correspond to overseas training and training and networking with VETIs. In their report on small scale CSP technologies (Rawlins & Ashcroft, 2013) identified capacity building as a key intervention in an effort to improve adoption of CSP systems for industrial application. They recommended creation of training courses, university courses and fellowships, and sponsorships.

4.7 Access to Finance and Likelihood of CSPT Adoption

The forth objective of this study sought to find out whether there is a relationship between access to finance and adoption of CSPT technology by tea factories managed by KTDA. Sub-variables in this analysis were adequate capital reserves, cost of credit, access to credit, collateral requirements, grants from government and development partners, subsidies, tax credits, venture capital, private public partnerships and insurance schemes. Results of the study on access to finance and adoption of CSPT is now presented starting with descriptive scenario and then the inference.

4.7.1 Descriptive Statistics on Access to Finance

The respondents expressed their views on preferred elements under access to finance that are likely to influence their factories to adopt CSPT. The elements of access to finance were adequate capital reserves, cost of credit, access to credit, collateral requirements, grants from government and development partners, subsidies, tax credits, venture capital, private public partnerships and insurance schemes. The manager's responses are summarized in Table 4.14.

Based on these results, the top three elements of access to finance that are likely to influence adoption of CSPT by the tea factories were having adequate capital reserves (with 24% strongly agree and 62% agree approvals), access to credit (with 13% strongly agree and 68% agree approvals) and availability of collateral securities (with 6% strongly agree and 55% agree approvals). These are followed by cost of capital, existence of venture capital funds, public private partnerships, and insurance schemes and. The average mean for the variable 'access to finance' was 3.12 with a standard deviation of 0.243. This means access to finance score as a possible influencer of adoption of CSPT by tea factories managed by KTDA can be as low as 2.877 (out of 5), and can be a maximum of 3.363.

Table 4.14: Managers Responses on Access to Finance Statistics

Access to Finance Methods	Percentage					Mean	Std. Dev.
	SD	D	DK	A	SA		
Factory had/has adequate capital reserves for installation a CSPT facility.	0	8	6	62	24	4.03	0.706
Factory had/has adequate credit facilities available for installation of a CSPT facility.	0	14	5	68	13	3.82	0.840
The cost of credit facilities influence the factory top adopt CSPT.	0	36	3	55	6	3.30	1.037
Collateral requirements to guarantee credit for installation a CSPT facility influences factory to adopt CSPT.	0	33	6	55	6	3.33	1.053
Adequate grant facilities from government available for procurement and installation of a CSPT facility influences factory to adopt CSPT.	5	50	39	6	0	2.47	0.684
Adequate grant facilities from development partners available for procurement and installation of a CSPT facility influences factory to adopt CSPT.	6	44	39	11	0	2.55	0.788
Subsidies offered for installation of a CSPT facility influences factory to adopt CSPT.	6	44	45	5	0	2.48	0.685
Tax credits offered for installing a CSPT facility influences factory to adopt CSPT.	6	41	47	6	0	2.53	0.706
Availability of venture capital funds for installation of a CSPT facility influences factory to adopt CSPT.	0	20	32	48	0	3.29	0.780
Availability of Public Private Partnerships for installation of a CSPT facility 1influences factory to adopt CSPT.	0	22	33	45	0	3.24	0.786
Availability of Insurance schemes on investments in CSPT facility influences factory to adopt CSPT.	0	14	36	50	0	3.29	0.699
Average						**3.12**	**0.243**

In the UNDP/GEF project with south India factories, funding was 46% grant by GEF while the balance 54% was co-financed by the government of India, Tea factories and the private sector (Ocampo & Marthel, 2012). Grant was a major contributor unlike in the KTDA manager' preference case, whereby it was approved by only eleven percent (11%) of the managers. Government contribution, factory capital reserves and public private partnerships have a similarity in both scenarios. In a similar project by UNIDO, GEF and MNRE in India promoting business models in concentrated heat energy technologies a soft loan scheme was established as an incentive. It was collateral free, interest at between 5-7%, a grace period of 1 year and repayment period of seven years (Misra A. 2016).Then there is the UNDP 'Energy Conservation in Small Tea Processing Units in South India' project, in which to remove financial barriers that hindering adoption of renewable energy technologies a commercial lending for investment in RE technologies was implemented. An insurance scheme was also developed and implemented. In general there seems to be a good match of financial incentives that would lure tea factories in Kenya to adopt CSPT with those that have been used for the same purpose elsewhere.

4.7.2 Inferential Statistics of Access to Finance and Adoption of CSPT

The fourth objective of this study was to find out the likelihood of access to finance to influence the adoption of CSPT among tea factories managed by KTDA. To enable measurement of this objective using field data, a fourth study hypothesis was developed which stated that:

$H_0$4: There is no significant relationship between access to finance and likelihood of adoption of CSPT among the Kenyan tea factories run by KTDA.

The elements of access to finance were adequate capital reserves, cost of credit, access to credit, collateral requirements, grants from government and development partners, subsidies, tax credits, venture capital, private public partnerships and insurance schemes. These sub-variables and CSPT adoption were regressed using the Firth algorithm. Results of the firth logistic regression are detailed in table 4.15.

The model scored a McFadden R^2 of 0.394. This falls within the perfect fit range of 0.2-0.4, and the model can be used to predict adoption of CSPT by tea factories managed by KTDA. However, the access to finance model was found to be statistically insignificant in influencing the likelihood of the adoption of CSPT by tea factories managed by KTDA, with a Chi^2 p-value of 0.6253. This was beyond the 0.05 threshold. This implies that access to finance was not significant in influencing the likelihood of the adoption of CSPT by tea factories managed by KTDA at 95% confidence level. By implication it would, therefore, not be one of the prime initiatives targeted to influence the adoption of CSPT among tea factories by KTDA. This will in turn lead to the acceptance of the forth hypothesis of this study which stated that 'There is no significant relationship between access to finance and adoption of CSPT among the Kenyan tea factories run by KTDA'. Consequently the variable 'access to finance' will be expunged from this study's model expressed in equation (xi).

Out of the eleven elements of access to finance only three were found to be statistically significant. These were grants from government (with a p-value of0.03423), grants from development partners (with a p-value of 0.03125) and public private partnerships (with p-value of 0.04901). The others were found to be insignificant in their likelihood to influence the adoption of CSPT as they had p-values beyond 0.05.

This finding has an interesting comparison with scenarios in projects mentioned earlier in adoption promotion efforts. All the project reports earlier from India and Malaysia had a component of enhancing access to finance especially through development partners' grants and attractive credit schemes (Misra A. 2016; Ocampo & Marthel, 2012; Akker & Aggarwal, 2015; Topo, Moretta, Glorioso & Pansini, 2014; UNDP, 2015). Actually the UNDP and UNIDO projects in India to promote adoption of CSTs started with grants from GEF. This highly corresponds with the expectations of the tea factory managers in Kenya, meaning if finance was to be considered in efforts to spur adoption of CSPT, then identification of organizations like UNDP and UNIDO would be required to bankroll the initiative.

Table 4.15: Access to Finance & Likelihood to Enhance Adoption of CSPT

N=66 Model: Firth Logistic regression (logitf) N of 0's: 63 1's: 3 (Access to Finance)

Penalized log likelihood = -1.06594 Prob> chi^2 = 0.6253

McFadden R^2=0.3904

	Const.B_0	Finance	Credit	Cost of C	Collateral	Grant	GrantD	Subsidies	Tax	Venture	PPP	Insurance
Estimate	-1.216653	0.94268	0.701705	0.054761	-1.200913	1.10249	1.217361	0.2004091	-0.17361	0.274923	0.5150226	-1.60901
p-value		0.05468	0.30136	0.48827	0.83884	0.03423	0.03125	0.08407	0.05674	0.381158	0.04901	0.72959
Odds ratio		2.5668	2.0171	1.0562	0.03009	3.01165	3.3426	0.8183	0.8406	1.3164	1.6736	0.2000

The access to finance model earlier expressed in equation (vii) will now be modified to the representation in equation (xiii) below.

Logist*f*(CSPT Adoption) = -1.216653 + 1.102GrntG + 1.217GrntD + 0.515Ppp **(xiii)**

Odd ratios calculated show grants with highest scores of over 3. However, availability of credit and cost of credit had higher odds than public private partnerships even though the two had been found to be statistically insignificant. This implies that when considered individually they may influence adoption of CSPT whenever they are varied by one unit. However when considered together with all the other covariates they are not likely to influence adoption of CSPT at 95% confidence level.

Further, just like in this study, access to finance was not found to be a key determinant in making the adoption decision. In the UNDP ‘Energy Conservation in Small Tea Processing Units in South India’ project, during implementation, project team realized access to finance was not a key barrier in investment in RE technologies (Ocampo & Marthel, 2012). The team had to adjust focus to other variables like awareness and technical capacity. In the other project ‘Market Development and Promotion of Solar Concentrators for Process Heat Applications in India Project’ in India, though friendly credit schemes were put in place, by the third year of implementation not a single investor had taken these benefit in their CST projects (UNDP, 2015). To a big extent, therefore, this study’s finding access to finance not a key initiative in the greater effort to promote adoption of CSPT among tea factories in Kenya is supported by these past relevant cases.

4.8 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.

4.8.1 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 4.16.

Table 4.16: Managers Responses on Standardization Elements Preferred

Elements of Standardization	Percentages SD	D	DK	A	SA	Mean	Std. 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.

4.8.2 Inferential Statistics 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 collected on these elements was regressed against the response variable (CSPT adoption) using Firth logistic algorithm. Regression analysis results are detailed in Table 4.17.

Table 4.17: 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 (viii) is replaced by equation (xiv).

$$\textbf{Logist}\boldsymbol{f}\textbf{ (CSPT Adoption)} = \boldsymbol{\beta} + \boldsymbol{\beta_5 X_5}$$

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

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.

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.

4.9 Determinants of the Likelihood of CSPT Adoption

Having investigated the likelihood of each of the five independent variables respectively to influence the adoption of CSPT, the study turns to investigate the combined effect of the five response variables on likelihood to influence adoption of CSPT by tea factories. This involves measuring the general objective of this study which was to find out the factors likely to influence the adoption of CSPT by tea factories managed by KTDA. In-turn, this requires testing the hypothesis to the general objective which stated:

$H_0$6: The independent variables (CSPT attributes, CSPT awareness, organization complexity, access to finance and standardization, have a combined effect on the likelihood of the adoption of CSPT among the Kenyan tea factories run by KTDA.

For this purpose aggregate scores were calculated for each of the independent variables. These aggregate scores were then fitted in a logistic regression against the dependent variable, adoption of CSPT. The results are show in Table 4.18.

Table 4.18: Combined Influence of the Determinants of Likelihood of Adoption of CSPT.

	Model: Firth Logistic regression (logit) N of 0's: 63 1's: 3 (Unweighted means) Dep. var: Adoption Loss: Penalized likelihood (MS-err. scaled to 1) Final loss: 22.856810392 McFadden R^2=.31629 Prob> chi^2=.0487					
	Constant	**Attributes**	**Awareness**	**Complexity**	**Finance**	**standardization**
Estimate	-5.274673	0.04503714	0.6330495	0.3710849	0.2342045	0.05385438
p-value		0.001277399	0.02724726	0.04480156	0.3881538	0.004278339
Odds Ratio		1.0460	1.8833	1.4493	0.7912	1.0553

The regression resulted in a McFadden R^2 of 0.316. This is within the perfect fit range of McFadden R^2 model fit test of 0.2-0.4. This means the five predictor variables combined can be used to predict the adoption of CSPT by tea factories. A test of significance of the model attained a score of 0.0487. This is below the 0.05 threshold for 95% confidence implying the model is statistically significant. This in-turn means that estimates of CSPT adoption gotten using this model cannot be attributed to chance with a confidence level of 95%.

Individual variables' significance was also measured. The predictor variables attributes, awareness, complexity, and standardization scored p-values of less than 0.05. This means they are statistically significant. However, access to finance had a score of 0.388 which is above the 0.05 mark, and is therefore not significant at the 95% confidence level. This suggests access to finance would not have a significant influence on the adoption of CSPT by tea factories and the variable should, therefore, not be included in the CSPT adoption model.

This confirms the results of statistical tests of significance exercise carried out in sections 4.4 to 4.8, in which four of the variables were found to be significant and therefore are likely to influence the adoption of CSPT among the tea factories. These were CSPT attributes, CSPT Awareness, organization complexity and CSPT standardization. These variables become covariates of the final study model. The variable, access to finance, was found to be insignificant and will therefore not be included in the final model.

To get the final CSPT adoption model, the remaining four predictor variables are regressed against the dependent variable, CSPT adoption. The results of this exercise are detailed in Table 4.19.

Table 4.19: CSPT Adoption Model Parameters

	Model: Firth Logistic regression (logit) N of 0's: 63 1's: 3 (Unweighted means) Dep. var: Adoption Loss: Penalized likelihood (MS-err. scaled to 1) McFadden R^2 =.3012 Prob> chi^2 =.0373				
	Constant	**Attributes**	**Awareness**	**Complexity**	**Standardization**
Estimate	0.288	2.71845	1.63304	1.02223	1.0002
p-value		0.017773	0.035247	0.048802	0.038278
Odds Ratio		15.1568	5.1194	2.7793	2.7188

These CSPT model scored McFadden R^2 of 0.3012 which is within the perfect fit expectation of McFadden R^2 between 0.2 and 0.4. Statistical significance sore was Chi squared p-value of 0.0373, which is within the 0.05 threshold. This means this model can be relied on in estimating adoption of CSPT technology among tea factories managed by KTDA at a 95% confidence level. This leads to the rejection of the null hypothesis H_{06} above, and a conclusion that the combined effect of the independent variables CSPT attributes, CSPT Awareness, organization complexity and CSPT standardization has an influence on the likelihood for the adoption of CSPT among tea factories managed by KTDA in Kenya.

The parameters for the new model are β_0 = 0.288, β_1 = 2.718, β_2 = 1.633, β_3 = 1.023, and β_4 = 1.002. Consequently the final study model expressing the likelihood of the adoption of CSPT among tea factories in Kenya is shown in equation (xiv) below.

$$\textbf{Logist}\boldsymbol{f}\textbf{ (CSPT Adoption) = 0.288+ 2.718CSPTAttributes + 1.633CSPTAwareness + 1.023OrganizationComplexity + 1.002CSPT Standardization} \quad \textbf{(xiv)}$$

The individual independent variable parameters in the above equation are measures by which an independent variable is likely to vary the likelihood of the adoption of CSPT technology by tea factories managed by KTDA, when varied by one unit within the model. CSPT attributes has the highest coefficient of 2.71, meaning it is the variable that would have the greatest effect in influencing the likelihood of adoption of CSPT by tea factories managed by KTDA. The second variable is awareness with a coefficient of 1.633, followed by complexity with a coefficient of 1.023 and finally standardization with a coefficient of 1.002. These, therefore, are the initiatives that are likely to influence the adoption of CSPT among the tea factories, and possibly in their priority order.

The same information is communicated through the odd ratios. These ratios give a measure of the extent to which a predictor variable can influence the likelihood of the dependent variable assuming a desired category, when varied by one unit, all other variables remaining constant. Again CSPT attributes had the highest ratio of 15.1568, implying a change in attributes by one unit will change the likelihood of the adoption of CSPT by over 15 times, all other things remaining constant. The order of importance of the covariates in the model as per their coefficients is repeated when odd ratios are considered. The second variable is awareness with a ratio of 5.1194, organization complexity is third with a ratio of 2.7793, and last is standardization with a ratio of 2.7188.

The significance of technology attributes emphasized in this study's findings is highlighted in Rogers' adoption of technology model. He attributed likelihood of adoption of a new technology to its relative to its attributes, followed by communication within a social set-up (Sahin, 2006). Communication creates awareness of the technology and its benefits. The attributes have also been found to have influence on faculty members' likelihood of adopting a new technology in their teaching. Further, just like in this study, Rogers identified the need for organization complexity, which he described as the extent to which organization members possessed skills and competences, as a perquisite to technology adoption. Nevertheless, Rogers' analysis does not indicate which attributes are more important in their influence on adoption. He also was silent on technology standardization as a factor influencing technology adoption.

More recent publications have highlighted all the determinants of technology investigated in this study. Reports on renewable energy and concentrated solar technologies promotion projects in India and Malaysia emphasized technology attributes (through demonstrations), awareness creation, capacity building and standardization as key initiatives to promote adoption (Akker & Aggarwal, 2015; Ocampo & Marthel, 2012: UNDP 2016). In these projects access to finance was incorporated as one of the initiatives to spur adoption of new technologies, but there was no reported strong connection of financial incentives and adoption of new technologies. In fact in one of the project it was reported that energy reforms can be initiated through awareness and technical support without any financial incentives. This is to a big extent in tandem with the findings of this study.

4.10 Revised Conceptual Framework.

This study started with a conceptual framework indicating the proposed relationships between the predictor variables CSPT attributes, CSPT awareness, organizational complexity, access to finance, and CSPT standardization, and the adoption of CSPT by KTDA run factories in Kenya. This framework was depicted in Figure 2.2. On completion of the investigation of the relationship between the dependent variable and the independent variables, and as per the results presented earlier in this chapter, the earlier proposed relationship slightly changes. One of the initial proposed dependent variables, access to finance, was found not to significantly influence the adoption of CSPT technology by tea factories run by KTDA. The variable was therefore expunged from the CSPT adoption model, and was consequently removed from the optimal conceptual framework. The optimal conceptual framework depicts the relationship between CSPT adoption by tea factories run by KTDA in Kenya and the independent variables that were found in the study to have an influence on the adoption of CSPT. These were CSPT attributes, CSPT awareness, organization complexity, and CSPT standardization. This modified framework is presented in Figure 4.2.

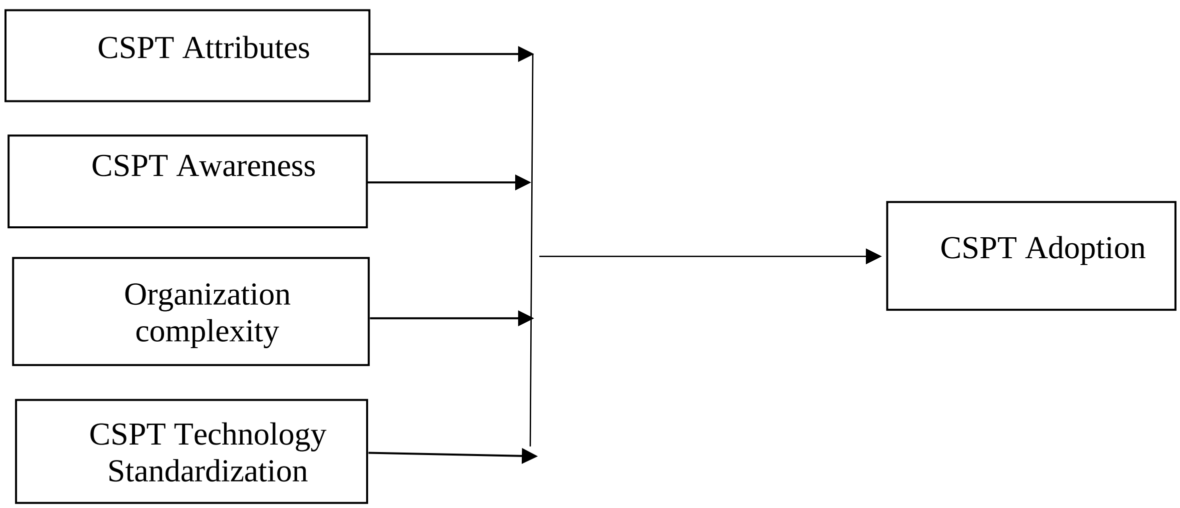

Figure 4.2 Revised Conceptual Framework

Beyond this revised framework a synopsis was done of the study conceptualization and findings. This was an attempt to capture at a glance the propositions, foundations, findings and conclusions of this study. This was done by highlighting these prime features of this study in a table form. This synopsis is depicted in Table 4.20.

Table 4.20: Determinants of the likelihood of Adoption of CSPT by Tea Factories Run by KTDA

Objective	Variable	Hypothesis	Model	Results	Conclusion
To analyse the effect of CSPT attributes on the likelihood of adoption of CSPT by tea factories run by KTDA in Kenya.	CSPT Attributes	**$H_0$1:** There is no significant relationship between CSPT attributes and likelihood of adoption of CSPT among the Kenyan tea factories run by KTDA	Logistf (CSPT Adoption) = β_0 + β_1**CSPTAttributes**	McFadden R^2 = 0.4135 Chi^2 p- value score = 0.0330.	p- value < 0.005 Reject **$H_0$1**
To assess the effect of CSPT awareness on the likelihood of adoption of CSPT by tea factories run by KTDA in Kenya.	CSPT Awareness	**$H_0$2:** There is no significant relationship between CSPT awareness and likelihood of adoption of CSPT among the Kenyan tea factories run by KTDA.	Logistf (CSPT Adoption) = β_0 + β_1**CSPTAwaneness**	McFadden R^2 = 0.2683 Chi^2 p- value score = 0.0482	p- value < 0.005 Reject **$H_0$2**
To explore the effects of organization complexity on the likelihood of adoption of CSPT by tea factories run by KTDA in Kenya.	Organization Complexity	**$H_0$3:** There is no significant relationship between organization complexity and likelihood of adoption of CSPT among the Kenyan tea factories run by KTDA.	Logistf (CSPT Adoption) = β_0 + β_1Organization Complexity	McFadden R^2 = 0.3177 Chi^2 p- value score =.01642	p- value < 0.005 Reject **$H_0$3**
To evaluate the effect of access to finance on the likelihood of adoption of CSPT by tea factories run by KTDA in Kenya.	Access to Finance	**$H_0$4:** There is no significant relationship between access to finance and likelihood of adoption of CSPT among the Kenyan tea factories run by KTDA.	Logistf (CSPT Adoption) = β_0 + β_1**Access to Finance**	McFadden R^2 = 0.3904 Chi^2 p- value score =0.6253	p- value > 0.005 Accept **$H_0$4**
To assess the effect of CSPT technology standardization on the likelihood of adoption of CSPT by tea factories run by KTDA in Kenya.	CSPT Standardization	**$H_0$5:** There is no significant relationship between CSPT standardization and likelihood of adoption of CSPT technologies among the Kenyan tea factories run by KTDA.	Logistf (CSPT Adoption) = β_0 + β_1**CSPTStandardization**	McFadden R^2 = 0.2277 Chi^2 p- value score = 0.0222	p- value < 0.005 Reject **$H_0$5**

4.11Chapter Summary

This chapter detailed the results of the study on the likelihood of the adoption of CSPT among tea factories managed by KTDA influenced by CSPT attributes, CSPT Awareness, organization complexity, access to finance and CSPT standardization. Four of these variables, CSPT attributes, CSPT Awareness, organization complexity, and CSPT standardization were found to have statistical significance in enhancing the likelihood of adoption of CSPT among the tea factories. Nevertheless, access to finance was not found to be significant in this role.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter presents the summary, conclusions and recommendations on the strategies for CSPT adoption among tea factories managed by KTDA in Kenya. Summary is a recap of the entire study highlighting the study objectives, process and findings. Based on the findings relevant conclusions are made followed by recommendations.

5.2 Summary

The general objective of this study was to clarify the strategies that have can enhance CSPT adoption by tea factories managed by KTDA in Kenya. Specific likely determinants of CSPT adoption which were investigated were CSPT attributes, CSPT awareness, organization complexity, access to finance and CSPT standardization. Specific objectives and corresponding hypotheses were formulated for each of these proposed determinants as to their likelihood to influence the adoption of CSPT.

This was followed by extensive review of theoretical and empirical literature on strategies for CSPT adoption which culminated in a conceptual framework for the study. This highlighted the causal likelihood relationship between CSPT adoption and the respective proposed determinants. Subsequently a target population was identified for the study and a questionnaire designed for the purpose of data collection. A pilot test was conducted at four private tea factories to test the validity and reliability of the research tool, which informed some adjustments in the tool and research topic. The questionnaire was applied in field data collection from the sixty six (66) tea factories managed by KTDA, and a hundred percent

(100%) response rate was attained. On completion of data collection, data analysis followed, making use of IBM SPSS statistics version 23 and STATSTICA version 12 softwares. The results of the analysis were used to test the six study hypotheses which were: There is no significant relationship between CSPT attributes and adoption of CSPT among the Kenyan tea factories run by KTDA; There is no significant relationship between CSPT awareness and adoption of CSPT among the Kenyan tea factories run by KTDA; There is no significant relationship between organization complexity and adoption of CSPT among the Kenyan tea factories run by KTDA; There is no significant relationship between access to finance and adoption of CSPT among the Kenyan tea factories run by KTDA; There is no significant relationship between CSPT standardization and adoption of CSPT technologies among the Kenyan tea factories run by KTDA; There is no significant relationship between CSPT standardization and adoption of CSPT technologies among the Kenyan tea factories run by KTDA; and There is no significant relationship between the combined effect of CSPT attributes, CSPT awareness, organization complexity, access to finance and standardization, and adoption of CSPT technologies among the Kenyan tea factories run by KTDA. Research findings per every objective are highlighted below.

5.2.1 CSPT Attributes and the Adoption of CSPT

The first study objective was ‘to assess the effect of CSPT attributes on the adoption of CSPT by the Kenyan tea factories run by KTDA’. The CSPT attributes investigated were CSPT cost effectiveness, minimizing carbon emissions, minimizing health hazard, being a twenty four hour source, being within required heat range, being easy to install, and being triable. All the attributes were found to be significant in their likelihood to influence the adoption of CSPT except 'being easy to install'. CSPT attributes, therefore have a likelihood of influencing the adoption of CSPT by the tea factories managed by KTDA. This result led to the rejection of the null hypothesis 'There is no significant relationship between CSPT attributes and the adoption of CSPT among the Kenyan tea factories run by KTDA'.

5.2.2 CSPT Awareness and the Adoption of CSPT

The second study objective was 'To assess the effect of CSPT awareness to influence the adoption of CSPT among the Kenyan tea factories run by KTDA'. Most of the respondents (89%) felt that there was no enough information on CSPT in the industry, but all of them were aware of the disadvantages of their current sources of heat energy (fuel wood and fuel oil). Farther, CSPT awareness creation approaches that would enhance the likelihood of CSPT adoption were investigated. These were use of brochures, use of posters, use of resource books, public presentations, public workshops, public exhibitions, newspaper advertisements, magazines advertisements and electronic publications. Five of these approaches were found to be statistically significant, which were use of brochures, public workshops, exhibitions, newspaper advertising and electronic publications. The awareness model with these sub-variables was also statistically significant which led to the rejection of the study's second hypothesis 'There is no significant relationship between CSPT awareness and adoption of CSPT among the Kenyan tea factories run by KTDA'.

5.2.3 Organization Complexity and the Adoption of CSPT

The third objective was 'To explore the effect of organization complexity on the adoption of CSPT among the Kenyan tea factories run by KTDA'. All the respondents agreed the technicians and engineers they had, had adequate level of education for CSPT installation and management training. However, only 67.2% felt the managers had adequate knowledge and skills for the management of CSPT. Farther investigation on technical training approaches identified three significant approaches, namely overseas training, net-works with universities and net-works with VETIs. The likelihood of organizational technical capacity to influence the adoption of CSPT model was also significant. This enabled the rejection of the third null hypothesis, 'There is no significant relationship between organization complexity and adoption of CSPT among the Kenyan tea factories run by KTDA'.

5.2.4 Access to Finance and the Adoption of CSPT

The forth objective of the study was 'To evaluate the effect of access to finance on the adoption of CSPT among the Kenyan tea factories run by KTDA'. These were grants from government, grants from development partners and public private partnerships. The others were found to be insignificant in their likelihood to influence the adoption of CSPT. The access to finance model was also overall found to be statistically insignificant in influencing the likelihood of the adoption of CSPT by tea factories managed by KTDA. This meant that though some elements of access to finance were significant, the overall variable performance in likelihood to influence adoption of CSPT was not good enough to be included in the overall study model. Consequently the independent variable 'access to finance' was dropped from the 'determinants of likelihood of adoption of CSPT by tea factories managed by KTDA' model.

5.2.5 CSPT Standardization and the Adoption of CSPT

The last objective was 'To assess the effect of CSPT technology standardization on the adoption of CSPT among the Kenyan tea factories run by KTDA'. The elements of CSPT standardization were quality assurance, assurance of installation procedures, KEBS mark, IS standard, KEREA accreditation and factory staff approval. All the elements of CSPT standardization were found to be significant, and so was the overall model. This led to the fifth study hypothesis, which stated that 'There is no significant relationship between CSPT standardization and adoption of CSPT technologies among the Kenyan tea factories run by KTDA', being rejected.

5.2.6 Determinants of the Adoption of CSPT

The general objective was evaluated last. It sought to 'to assess the effect of combined effects of CSPT attributes, CSPT awareness, organization complexity, access to finance and CSPT standardization on the adoption of Concentrated Solar Power Technologies (CSPT) among the Kenyan tea factories run by KTDA'. As explained above, access to finance was eliminated from this combined effect, as it was found to be statistically insignificant. Thus, ultimate model of determinants of CSPT adoption likelihood by tea factories managed by KTDA ends with four co-variants namely of CSPT attributes, CSPT awareness, organization complexity, and CSPT standardization. These final model was expressed by equation (xiv).

$$\textbf{Logist}\boldsymbol{f}\textbf{ (CSPT Adoption) = 0.288+ 2.718CSPTAttributes + 1.633CSPTAwareness}$$
$$\textbf{+ 1.023OrganizationComplexity + 1.002CSPT Standardization} \quad \textbf{(xiv)}$$

5.3 Conclusions

In the light of the results discussed above, several conclusions can be made. These are discussed in this section, mostly following the study objectives' sequence. The study found out that no tea factory managed by KTDA was using CSPT. This is despite CSPT's strong attributes and appeal considering Kenya, and therefore the tea factories, have an above average solar resource. Nevertheless, three of the factories were in the process of adopting the technology. Results of this study have pointers to possible explanations of this paradox.

For a start the study found out that there is very little information available on CSPT to the industry. As many as 89% of the managers attested to this fact. It was worse when it came to awareness of CSPT suppliers where those without a clue were a whopping 92%. Considering the foregoing, it can be logically concluded that lack of information on CSPT is likely to have contributed to the non-adoption of CSPT technology. This is more so considering that most of the respondents liked most of the attributes of CSPT (such as cost efficiency, less health hazard, less pollution, and being a twenty four hour energy source). More information on CSPT technology, its benefits and suppliers might entice the factories to install this novel technology. The respondents also identified preferred vehicles for transmitting CSPT information. Out of that result it can be conclude that the best media for disseminating CSPT information in the industry are exhibitions, electronic publications, public workshops, newspapers and brochures, in that order.

The respondents posited that most of the technical staff had the basic education level required for CSPT training. However, according to the managers only 67% could be able to manage a CSPT system. Though this is a substantially good proportion, in my view it was not consistent with the fact earlier stated that there is very little information on CSPT. This implies they could have overestimated those that are likely to manage a CSPT system. All the same, there is an indication of lack of specialized training and skills in CSPT. The proposition of this study, therefore, is that there is need for specialized training on CSPT. Further, preferences of delivery modes of this training were made by the respondents. Overseas training was most preferred followed by training at the vocational training institutes and net-working with universities.

Respondent gave their take on access to finance. Most of the managers indicated that the factories have adequate capital reserves, access to credit, and have collateral security that might be required for CSPT installation. Meaning lack of finance inform of organization reserves and access to credit were not a contributor to non-adoption of CSPT. Yet they had not adopted this technology. It can therefore be concluded that access to financial resources was not among the more likely factors to have hindered adoption of CSPT. However, some of the elements under access to finance were reported to be likely to influence adoption of CSPT. These were grants (from government and development partners) and joint ventures. The grants were also found to be a frequent tool in initiating CSPT projects especially in India spearheaded by UNDP, UNIDO and GEF. It is, therefore, a path that can be investigated and pursued in efforts to encourage adoption of CSPT among the tea factories.

Results on CSPT standardization showed the factory managers would highly need assurance on CSPT standards before they can adopt the technology. ISO certification mark, KEREA accreditation and KEBs mark of quality were top preferences in assuring the respondents on CSPT quality. It can therefore be concluded that to enhance the likelihood of the adoption of

CSPT by tea factories managed by KTDA there is need to make sure CSPT is ISO certified, accredited by KEREA or bearing KEBS mark of quality.

5.4 Recommendations

From the findings and conclusions of this study CSPT attributes, CSPT awareness, CSPT standardization and organization complexity were found to have a likelihood to influence the adoption of CSPT. In the view of the researcher, to enhance likelihood of adoption of CSPT by the factories through influence of CSPT attributes, CSPT awareness is a prerequisite. The factory management and the entire industry need to be knowledgeable about the CSPT attributes for them to be persuaded to take up the technology. Massive awareness campaigns, particularly through exhibitions, electronic publications, public workshops, newspapers and brochures, are required to enhance the likelihood of the tea factories adoption of CSPT. This can be an initiative all stakeholders especially CSPT suppliers, the Kenya government, sustainable energy interest groups and development agencies.

It is also apparent there is little local specialized technical capacity on CSPT. To improve the likelihood of the adoption of CSPT by the factories specialized technical training on CSPT for engineers and technicians should be undertaken. This can be done in the short term by taking existing staff for short courses overseas (to China, India, and Spain) where this technology is developed and being used. Considering the factories did not seem to have financial shortcomings, this is an initiative they can take up. For longer term impact CSPT training in form of CSPT specialization options in universities and vocational training institutes should be embarked on. This is more of a government and development agencies forte.

To enhance the likelihood of CSPT adoption the prospective customers (tea factories) will need assurance of the quality and authenticity of the CSPT equipment. Assurance that the CSPT equipment would deliver as alleged. This assurance will be midwifed by having the CSPT suppliers, equipment and installation procedures being endorsed by ISO, KEREA and KEBS. This onus falls in the hands of the CSPT manufacturers, the Kenya government, KEREA and KEBS.

5.5 Areas for Further Research

This study heavily relied on Rogers' theory on technology adoption to identify likely determinants of CSPT adoption. However, not all variables proposed in the said theory were investigated in this study. Particularly, Rogers emphasized on organizational structural characteristics, which were centralization, complexity, formalization, Interconnectedness and Organizational slack. Only the effect of organization complexity was investigated in this study. There is room, therefore, for the investigation of these other variables in their likelihood to influence the adoption of CSPT.

Finally, this study focused on the likelihood of adoption of CSPT in the tea industry. This is only one sector using heat energy and that may benefit from this relatively new and environmentally friendly source of heat. Studies can therefore be conducted in other sectors to investigate the likelihood of industrial application of CSPT in Kenya.

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APPENDICES

APPENDIX I: INTRODUCTION LETTER

David M. Magu
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Tel: 0722397902
david.magu@dkut.ac.ke

Dear Sir/Madam,

RE: **REQUEST TO OBTAIN INFORMATION ABOUT CONSENTRATED SOLAR ENERGY TECHNOLOGY**

As part of a process leading to the award of Doctor of Philosophy degree in Business Administration and Management, I am undertaking a study entitled "Market Drivers for the Diffusion of Concentrated Solar Power Technology among KTDA Run Tea Factories in Kenya". The aim of the attached questionnaire is to assist me develop an understanding of the forces influencing the adoption of the CSPT technology by the target factories, and factors that will influence entrepreneurs to participate in CSPT value chain. Your ideas will be helpful towards my PHD qualification at Dedan Kimathi University of Technology, and also provide useful insights for the tea industry in Kenya pursuit of a sustainable heat energy solution.

Please note the data obtained using this questionnaire is purely for academic purpose and your identity with remain confidential.

Yours Faithfully,

David M. Magu
REG. B311-03-1569/2014

APPENDIX II: FACTORY MANAGERS QUESTIONNAIRE

This questionnaire is designed purposely for academic research only. It is meant to help the researcher draw valuable conclusions regarding the diffusion of Concentrated Solar power Technologies (CSPT) among tea factories run by KTDA in Kenya. Your participation is considered of great value towards the completion of this study. In addition the information obtained from your organization remains confidential and adherence to research ethics is going to be upheld. Thank you for your participation.

SECTION A: GENERAL INFORMATION

1. Age bracket of respondent
   - i) below 30 years ☐
   - ii) 30 – 40 years ☐
   - iii) 41 – 50 years ☐
   - iv) Over 50 years ☐
2. Respondent work experience in a tea factory
   - i) 0 - 5 years ☐
   - ii) 6 – 10 years ☐
   - iii) Over 10 years ☐

SECTION B HEAT ENERGY USES AND SOURCES

This section has questions regarding the sources and uses of heat energy in your factory. Kindly respond by ticking the option that best matches your opinion on the sources and usage.

1. The following are the key activities that use energy in a tea factory. Indicate the approximate heat energy taken up by each of the following factory processes as a percentage of the total energy use at your factory per year.

Use	Tick as appropriate						
	Below 2.5 %	2.6 – 5%	5.1-7.5%	7.6-10 %	10.1-12.5 %	12.6-15%	Over 15 %
Withering							
Drying							

2. The following are the main sources of energy in a tea factory. Indicate the approximate contribution of energy heat by each of the following energy sources as a percentage of the total factory day-to-day energy heat requirement.

Source	Tick as appropriate						
	Below 5 %	5 – 10%	11-20 %	21-40 %	41-60 %	61-80 %	Over 80%
Fuel wood							
Briquettes							
Fuel oil							

3. Indicate to what extent each of the following factors are a challenge to your factory in using the current sources of process heat?

Factor	Not at all	To a small extent	To a moderate extent	To a high extent	To a very high extent
High prices					
Volatile price					
Polluting (carbon emissions)					
Getting depleted					
Negative health effects					
Intermittent (not always available)					
Cumbersome/aesthetics					
Other (specify)					

SECTION C: CONCENTRATED SOLAR POWER TECNOLOGY (CSPT)

This section has statements regarding consideration for adopting CSPT.

CSPT ATTRIBUTES AND ADOPTION OF CSPT

Rate the characteristics of CSPT that influenced/can influence your factory to install CSPT by indicating your level of agreement or disagreement with each of following statements on a five point Likert scale where 1= Strongly Disagree, 2= Disagree, 3= Don't Know, 4= Agree and 5= Strongly Agree.

S/No	**Characteristics**	**Strongly disagree**	**Disagree**	**Don't Know**	**Agree**	**Strongly Agree**
		1	**2**	**3**	**4**	**5**
1.	CSPT is more cost effective than other sources of heat energy the factory has been using					
2.	CSPT is clean energy that enables the organization minimize carbon emissions					
3.	CSPT is clean energy that enables the organization minimize health hazards to employees					
4.	CSPT is a 24/7 source of heat energy					
5.	CSPT generates heat energy in the range requirement of the factory (50^0-120^0C)					
6.	CSPT is easy to install					
7.	CSPT can be tried before purchase and installation					

SECTION D: CSPT AWARENESS

AWARENESS STATUS

Indicate the level to which you agree with the following statements on the status of awareness of CSPT in your factory.

	Status	Strongly disagree	Disagree	Don't Know	Agree	Strongly Agree
1.	There is adequate information on what CSPT is among the KTDA factories management					
2.	The factory management is aware of the benefits of CSPT over other sources of heat energy					
3.	The factory management knows the suppliers of CSPT					
4.	The factory management is aware of the disadvantages of fuel-wood as sources of heat energy					
5.	The factory management is aware of the disadvantages of fuel-oil as sources of heat energy					

AWARENESS AND ADOPTION OF CSPT

The following facts relate to approaches for creating awareness of CSPT. Kindly respond as to the extent to which each statement would influence a decision to adopt CSPT by your factory. Rate awareness creation approach that influenced/ would influence your factory to install CSPT by indicating your level of agreement or disagreement with each of following statements on a five point Likert scale where 1= Strongly Disagree, 2= Disagree, 3= Don't Know, 4= Agree and 5= Strongly Agree.

S/ No	Awareness Creation	Strongly disagree	Disagree	Don't Know	Agree	Strongly Agree
		1	2	3	4	5
1.	Awareness of CSPT through brochures influenced/will influence factory to adopt CSPT					
2.	Awareness of CSPT through posters influenced/will influence factory to adopt CSPT					
3.	Awareness of CSPT through resource books influenced/will					

S/ No	Awareness Creation	Strongly disagree	Disagree	Don't Know	Agree	Strongly Agree
		1	2	3	4	5
	influence factory to adopt CSPT					
4.	Awareness of CSPT through Public presentations influenced/ will influence factory to adopt CSPT					
5.	Awareness of CSPT through Public workshops influenced/ will influence factory to adopt CSPT					
6.	Awareness of CSPT through Public Exhibitions influenced/will influence factory to adopt CSPT					
7.	Awareness of CSPT through Advertisements in newspapers influenced/will influence factory top adopt CSPT					
8.	Awareness of CSPT through Advertisements in magazines influenced/will influence factory top adopt CSPT					
9.	Awareness of CSPT through Advertisements in electronic publications influenced will/influence factory top adopt CSPT					

SECTION E: ORGANIZATION COMPLEXITY

COMPLEXITY STATUS

Indicate the level to which you agree with the following statements on the status of technical capacity for CSPT adoption in your factory.

		Strongly disagree	Disagree	Don't Know	Agree	Strongly Agree
1.	The current factory engineers have the knowledge to manage a CSPT facility					
2.	The current factory engineers have the skills to install and manage a CSPT facility					
3.	There is need for specialized training on CSPT installation for engineers before installation of a CSPT facility					
4.	There is need for specialized training on CSPT operations for technicians before installation of a CSPT facility					
5.	There is need for specialized training on CSPT maintenance for technicians before installation of a CSPT facility					
6.	The current level of education of the engineers prepares them well for CSPT training					
7.	The current level of education of the technicians prepares them well for CSPT training					

COMPLEXITY AND ADOPTION OF CSPT

The following facts relate to approaches that would enhance organization complexity for CSPT adoption. Kindly respond as to the extent to which each statement would influence a decision to adopt CSPT by your factory

Rate the technical capacity improvement method that influenced/ would influence your factory to install CSPT by indicating your level of agreement or disagreement with each of following statements on a five point Likert scale where 1= Strongly Disagree, 2= Disagree, 3= Don't Know, 4= Agree and 5= Strongly Agree.						
S/No	**Technical Capacity Approach**	**SD**	**D**	**DK**	**A**	**SA**
		1	**2**	**3**	**4**	**5**
1.	Technical skills training on CSPT through On-the-job training will influence factory top adopt CSPT					
2.	Technical skills training on CSPT through Overseas training will influence factory top adopt CSPT					
3.	Technical skills training on CSPT through formal education programs will influence factory top adopt CSPT					
4.	Technical skills training on CSPT through informal education programs will influence factory top adopt CSPT					
5.	Technical skills training on CSPT through Networks of Factories with Universities Research institutions will influence factory to adopt CSPT					
6.	Technical skills training on CSPT through Networks of Factories with Vocational Education Training Institutions will influence factory to adopt CSPT					

7 SECTION F: ACCESS TO FINANCE

The following facts relate to access to finance. Kindly respond as to the extent to which each statement would influence a decision to adopt CSPT by your factory

Rate the importance of access to finance facts that influenced/ would influence your factory to install CSPT by indicating your level of agreement or disagreement with each of following statements on a five point Likert scale where 1= Strongly Disagree, 2= Disagree, 3= Don't Know, 4= Agree and 5= Strongly Agree.

S/No	**Characteristics**	**SD**	**D**	**DK**	**A**	**SA**
		1	**2**	**3**	**4**	**5**
1.	The factory had/has adequate capital reserves for installation a CSPT facility.					
2.	The factory had/has adequate credit facilities available that influenced/will influence installation of a CSPT facility.					
3.	The cost of credit facilities available for installation of a CSPT facility were/are low and influenced/will influence the factory to adopt CSPT.					
4.	Collateral requirements to guarantee credit were available and influenced/will influence factory to adopt CSPT.					
5.	Adequate grant facilities from government available influenced/will influence factory to adopt CSPT.					
6.	Adequate grant facilities from development partners available influenced/will influence factory to adopt CSPT.					
7.	Subsidies available for installation of a CSPT facility influenced/will influence factory to adopt CSPT.					
8.	Tax credits offered for installing a CSPT facility influenced/will influence factory to adopt CSPT.					
9.	Availability of venture capital funds for installation of a CSPT facility influenced/will influence factory to adopt CSPT.					
10.	Availability of Public Private Partnerships for installation of a CSPT facility influenced/will influence factory to adopt CSPT.					
11.	Availability of Insurance schemes on investments in CSPT facility influenced/will influence factory to adopt CSPT.					

8 SECTION G: CSPT TECHNOLOGY STANDARDIZATION

The following facts relate to CSPT technology standardization. Kindly respond as to the extent to which each statement would influence a decision to adopt CSPT by your factory

Rate the importance CSPT products standardization facts that influenced/ would influence your factory to install a CSPT facility by indicating your level of agreement or disagreement with each of following statements on a five point Likert scale where 1= Strongly Disagree, 2= Disagree, 3= Don't Know, 4= Agree and 5= Strongly Agree.						
		SD	**D**	**DK**	**A**	**SA**
S/No	**Characteristics**	**1**	**2**	**3**	**4**	**5**
1.	The factory management needed/will need assurance on the quality of the CSPT equipment.					
2.	The factory management needed/will need assurance of standard installation procedures of the CSPT equipment.					
3.	CSPT equipment bearing KEBS mark of quality for imported goods (ISM) influenced/will influence the factory management decision to install CSPT.					
4.	CSPT equipment meeting ISO/TC 180 solar energy standard influenced/will influence the factory management decision to install CSPT.					
5.	CSPT and supplier accredited by KEREA influenced/will influence the factory management decision to install CSPT.					

SECTION H: CSPT INSTALLATION FACTORY STATUS

The following facts relate to CSPT adoption status of your factory. Kindly respond to each of the statements as best as you can.

Rate the CSPT adoption status of your factory in the adoption process stages by indicating your level of agreement or disagreement with each of following statements on a five point Likert scale where 1= Strongly Disagree, 2= Disagree, 3= Don't Know, 4= Agree and 5= Strongly Agree.						
		SD	**D**	**DK**	**A**	**SA**
S/No	**Characteristics**	**1**	**2**	**3**	**4**	**5**
1.	No effort made in CSPT adoption process (Prior)					
2.	The factory management is in information search stage of CSPT adoption process					
3.	The factory management is in information evaluation stage of CSPT adoption process					
4.	The factory management has made a decision to adopt CSPT technology					
5.	The factory management has installed CSPT technology					
6.	The factory management is now in post installation evaluation					

APPENDIX III: THE 66 TEA FACTORIES RUN BY KTDA BY REGION

REGION	FACTORIES	NUMBER
1. Aberdare Ranges I	Kambaa, Mataara, Kagwe, Theta, Ngere, Ikumbi, Ndarugu,Gachege,Njunu, Nduti,Makomboki,Gacharage	12
2. Aberdare Ranges II	Githambo, Kanyenyaini, Kiru, Gatunguru, Chinga, Iriaini, Gitugi, Gathuthi, Ragati	9
3. Mt. Kenya	Ndima, Kangaita, Mununga, Kimunye,Thumaita, Kathangariri, Mungania, Rukuriri	8
4. Mt.Kenya & Nyambene Hills	Weru, Kinoro, Kionyo, Imenti, Githongo,Igembe, Michimikuru, Kiegoi	8
5. Kericho Highlands	Toror, Tegat, Momul, Litein, Chelal, Kapkatet, Mogogosiek, Kobel, Kapset, Rorok, Kapkoros, Tirgaga.	12
6. Kisii Highlands	Sanganyi, Tombe,Gianchore, Nyansiongo, Kebirigo, Nyankoba, Rianyamwamu, Itumbe, Nyamache, Ogembo, Eberege. Kiamokama	12
7. Nandi Hills & Western Highlands	Chebut, Kaptumo, Mudete, Kapsara, Olenguruone	5

APPENDIX IV: LETTER OF RESEARCH AUTHORIZATION

NACOSTI

NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY AND INNOVATION

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NAIROBI-KENYA

Ref. No. **NACOSTI/P/17/91730/16410**

Date: **24th March, 2017**

David Muchunu Magu
Dedan Kimathi University of Technology
P.O.Box 657-10100
NYERI.

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on **"*Factors limiting adoption of Concentrated Solar Power Technologies among tea factories in Kenya,*"** I am pleased to inform you that you have been authorized to undertake research in **all Counties** for the period ending **24th March, 2018.**

You are advised to report to **the County Commissioners and the County Directors of Education, all Counties** before embarking on the research project.

On completion of the research, you are expected to submit **two hard copies and one soft copy in pdf** of the research report/thesis to our office.

BONIFACE WANYAMA
FOR: DIRECTOR-GENERAL/CEO

Copy to:

The County Commissioners
All Counties.

The County Directors of Education
All Counties.

National Commission for Science, Technology and Innovation is ISO 9001:2008 Certified

APPENDIX V: RESEARCH PERMIT

THIS IS TO CERTIFY THAT:
MR. DAVID MUCHUNU MAGU
of DEDAN KIMATHI UNIVERSITY OF TECHNOLOGY, 657-10100 Nyeri,has been permitted to conduct research in
All Counties County

Permit No : NACOSTI/P/17/91730/16410
Date Of Issue : 24th March,2017
Fee Recieved :Ksh 2000

on the topic: ***FACTORS LIMITING ADOPTION OF CONCENTRATED SOLAR POWER TECHNOLOGIES AMONG TEA FACTORIES IN KENYA.***

for the period ending:
24th March,2018

....
Applicant's Signature

....
Director General
National Commission for Science, Technology & Innovation