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Factors Influencing the Adoption of Solar Energy Technology in Katulani Sub-Location, Kitui District.

By

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Declaration

I declare that this is my original work and has not been presented in any other institution for the award of a degree.

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Date 9/11/07

Declaration by supervisor

This thesis has been submitted with my approval as a University supervisor.

Supervisor: Mr. Kamau Mubuu

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Date: 15/11/07

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Dedication

To my wife Francisca, daughter Mary and sons Kelvin and Abel. Being your father is the greatest privilege and honour God has bestowed upon me. May your generation create a future, digital and otherwise that will take human achievement to new heights.

Abstract

This study is undertaken to establish the real factors that inhibit the adoption of solar technology in Katulani Sub-Location.

As with most renewable energy system, there are initial costs involved, which make setting projects initially expensive, however, the savings on electricity bills in the long term should make up for this. The technology is now 90 percent cheaper than it was in 1970s.

Solar energy once adopted can be ideal for both rural and urban areas. Solar technology can play a crucial role in moving towards affordable net-zero energy homes and business which combines energy produced on site. Efficient buildings with solar power generation can help reduce peak demand and ease the need for expensive new generating capacity/transmission and distribution as our economy grows.

Conserving and developing new sources of energy for household will save much time and money as most of the Kenya's fuel energy is used in households. As the demographic structure of Kenya changes, the energy needs of people also change. Although wood fuel still serves most of the country's energy requirements, there are important differences between today's energy consumption patterns and traditional energy needs.

Modern living styles require more energy. Infact, simply keeping with energy requirement of rising population makes considerable demands on the environment and economy. Today in many places, Katulani sub-location included, energy crisis is the wood-fuel shortage hence forcing people to rely on Agricultural waste. Women spend much time walking long distance in search of wood fuel.

In cities, most people cook with charcoal. Wood is scarce in towns because it cannot be economically transported over large distance. Charcoal is more convenient than wood and is more suitable for urban use but it is expensive for those with scarce resources.

This study seeks to establish the factors that limit widespread adoption of solar as the alternative source of energy in Katulani sub-location. The study was prompted by the fact that wood fuel is increasingly getting depleted through human activities while other sources of energy are expensive for most households in the rural areas. Therefore solar energy, which according to this study has been found to be sufficiently available should be adopted by all households in order to cater for domestic demands.

The study was carried out in Katulani sub-location of Kitui District. Katulani location has sunshine throughout the year thus making it ideal for solar usage. This location is found in the surburbs of Kitui town enabling anybody wishing to procure solar panels and other accessories conveniently. Out of 1000 homesteads, a purposeful sample of 100 respondents was selected and used for the study. This represented 10% of the population.

Major findings of the study reveal that 75% of those interviewed do not use solar energy in their homes. Relatives and friends 43.75%, newspaper and advertisements (38.75%), neighbours 30% are very instrumental in creating awareness. The main reason for none adoption of solar technology is the cost associated with its installation. Around 51.75% said that the cost of installation,, the actual purchase of panels and other accessories is way beyond their means. Lack of skilled personnel to install the technology was also cited as a factor contributing to slow adoption of the technology.

Data was collected using interview guides, observations and review of the relevant information on solar energy adoption. The data collected was tabulated, frequencies drawn and analysed using simple statistical methods such as average (mean), percentages and presented using bar charts, pie charts and histogram.

Based on the findings of the study, the following recommendations have been made: the reduction of the cost of solar panels, training of human resources to handle the installation and maintenance, increase awareness campaign through the use of folk media, offer credit facilities to stimulate purchase, demonstration of solar technology, offer after sale services and encourage women participation in the adoption process.

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CHAPTER ONE: INTRODUCTION

1.1 Introductory Background

This study seeks to establish factors inhibiting wide spread adoption of solar lighting technology in Katulani Sub-Location of Kitui District. Inventors unlocked the secrets of turning the sun's rays into mechanical power more than a century ago, only to see their dream machines collapse from lack of public support. Modern solar engineers must not be doomed to relive their fate.

The efforts to design and construct devices for supplying renewable energy began about a 100 years before that turbulent time – ironically, at the very height of the Industrial Revolution, which was largely founded on the promise of seemingly inexhaustible supplies of fossil fuels. Contrary to the prevailing opinion of the day, a number of engineers questioned the practice of an industrial economy based on non-renewable energy and worried about what the world's nations would do after exhausting the fuel supply.

Most importantly, many of these visionaries did not just provide futuristic rhetoric, but actively explored almost all the renewable energy options familiar today. In the end, most decided to focus on solar power, reasoning that the potential rewards outweighed the technical barriers. In less than 50 years, these pioneers developed an impressive array of innovative techniques for capturing solar radiation and using it to produce the steam that powered the machines of that era. In fact, just before World War 1, they had outlined all of the solar thermal conversion methods now being considered. Unfortunately, despite their technical successes and innovative designs, their work was largely forgotten for the next 50 years in the rush to develop fossil fuels for an energy-hungry world.

Now, a century later, history is repeating itself. After showing the same path as the early inventors – in some cases reinventing the same techniques – contemporary solar engineers have arrived at the same conclusion: solar power is not only possible but eminently practical, not to mention more environmentally friendly. Once again, just as the technology has proven itself from a practical standpoint, public support for further development and implementation is eroding, and solar power could yet again be eclipsed by conventional energy technologies.

The dry lands are endowed with enough sunshine to generate electricity which can be sold to the rest of the country or even exported. The amount of solar energy received in the dry lands is one of the highest, and can be trapped and commercialized if the government makes the right investment. According to Prof. Uriel Sapheriel a specialist on ecology and environment at Hebrew university in Jerusalem

> *"The biggest problem is that most governments have not exploited the huge economic potential in dry lands. Instead they have neglected them, when Israel is a testimony that those lands are sleeping economic giants". – (Sapheriel, Daily Nation/Tuesday 29,2006)*

Talking to *Daily Nation*, Prof. Sapheriel (2006) said that Israel after successful afforestation and fish farming in dry lands is now using powerful solar panels weighing about 400 tonnes to generate electricity for the country.

During a recent international conference on desertification held in Nairobi (2006), it was recommended that developed countries come up with inexpensive solar harvesting technologies to help their poor nations exploit the potential in their dry lands. In addition to solar harvesting, Israel pumps water from the underground aquifers to sustain a thriving commercial and domestic fish industry in some very dry habitats. Although the process is expensive, Prof. Sapheriel says Kenya can exploit global funding mechanisms like the Kyoto protocol where rich nations are willing to fund afforestation programmes in Africa to check global warming.

Katulani sub-Location being in tropics and with a semi-arid environmental conditions, experience acute shortage of wood fuel. Solar technology are now widely used in world round in Kenya in particular. However there is yawning gap among the people of Katulani sub location away as the adoption and use of solar energy is concerned. In Kenya there is sustained media campaign of use of other alternative source of fuel. Nevertheless, there is low levels of solar usage in Katulani Sub-Location. This study therefore seeks to establish the factors that inhibit wide spread adoption of solar energy in the area.

Firewood s the traditional energy source for cooking in the majority of countries of the developing world. The FAO estimates that 2 billion people worldwide, experience serious

problems with their cooking fuel supply. High population density, deforestation and soil erosion causes severe environmental degradation. The use of fossil fuels for cooking also aggravates poverty and impacts negatively on local economies. Solar light technology as an environmentally friendly technology could contribute to the solution – provided that the technology is accepted by end-users that the solar technologies are both appropriate and affordable.

1.2 The Statement of the problem

Solar energy can be put into many domestic uses such as refrigeration, powering video, television, solar water pumps, charging mobile phones, water heating and solar home lighting. This study seeks to establish the factors that hinder the wide spread adoption of solar energy technology in Katulani Sub-Location of Kitui District in the interests of increasing broader adoption of solar technologies in the area. Specifically, the study seeks answers to the influence of the social economic status of people in adoption of new technology. As it is now, the level of use of solar technology is awfully low. Further, the study seeks answers to questions as to what channels are used to disseminate information on new technology. The change agent involved and what makes people accept a reject a given innovation or technology.

Firewood is the **traditional energy source for cooking** with the majority of countries of the developing world. The FAO estimates that 2 billion people worldwide experience serious problems with their cooking and lighting fuel supply. High population density, deforestation and soil erosion can cause severe environmental degradation. The use of fossil fuels for cooking also aggravates poverty and impacts negatively on local economies. Solar technology has environmentally friendly technology could contribute to the solution–provided that the technology is accepted by the end-users and that the solar technology are both appropriate and affordable.

1.3 The objectives of the study

The objectives of the study are:

1. To identify and examine the level of solar energy use in the Katulani Sub-Location.
2. To examine and investigate the factor influencing the adoption of solar energy technology in Katulani Sub-Location.
3. To recommend measures that can be used to gain widespread adoption of solar technology in Katulani sub-location.

1.4 Justification of the study

Solar energy is a convenient source of energy. The adoption and use of the solar energy can go a long way in complementing government efforts to supply electricity in all parts of the country. Kenya experiences abundant sunshine which goes unutilized. The adoption of solar energy therefore cannot only ease the problem of over reliance on Hydro Electric Power(HEP) but also will supplement it. Over reliance on Hydro Electric Power (HEP) has often led to power shortage or power rationing especially during prolonged droughts. Although the initial installation of the solar technology may be high, its operational cost is minimal in the long run.

The adoption of solar energy will enhance education in computer technology and subsequently improve communication in general. It is important to note that our society has created technological revolution, and unless we meet the needs of all our students population we will soon have electronic "ghettos". Thus it is important to deliver technology to all segments of the population. If we fail to do so as society we will create digitally illiterate second class citizen who will face closed doors when it comes to good jobs and growth opportunities eventually leading to economic deprivation for those individuals.

The adoption of solar energy will therefore help in bridging the digital divide between the rural and urban areas in Kenya. Therefore the goal of any technology adoption activating such solar technology adoption should be thought to be exclusively directed toward accelerated adoption by the users. A frequently underused benefit is the feedback, which will keep maintaining relevance and direction of research and development activities in the area of solar technology and be used

to direct and prioritise research and development, suggest policy or legislate changes and keep set incentives.

Technology adoption forms an essential part of any technology program, providing mechanism for communication with the potential users as well as policy makers. In return, valuable feedback is obtained that can be used to shape future technology development activities.

1.5 Definition of key terms

1. **Adopt** - To accept a new thing, practice or idea. According to the theory of adoption, every innovation is taken up by people in a particular society in a rather regular process. This process is well described by the theory of adoption of innovation. Innovation theory is important to the study of mass communication in that media are often largely responsible for bringing new items to the attention of the people who eventually adopt them.

2. **Diffusion** - According to Rogers and Schoemaker (1973) diffusion refers to the mass communication process whereby innovation moves from point of origin and spreads to other areas.

CHAPTER TWO

Literature Review

2.1 Introduction

This chapter will provide seminal Ideas that inform this study. The theoretical basis for the study and major variables that influence the adoption of innovations will be considered . More importantly an attempt is made to propose a frame work for the study of adoption of solar technology that is based on models and concepts from various disciplines in social science and past research on diffusion on innovations of new technology.

2.2.1 Technology adoption.

According to Hanley and Thornton (2004), getting a new technology adopted by either a specific user group or by the general public has been shown repeatedly to be extremely difficult. Even though a newer technology may have obvious benefits over older, more established technologies, acceptance is rarely "a done deal."

"Technical diffusion" is a general term that describes the process by which a new idea is adopted and has been applied to all fields of human endeavor. The term is often applied to both the planned and spontaneous spread of new ideas.

Many innovations that we routinely accept today, such as the automobile and alternating-current (ac) electricity, actually took many years before they gained widespread acceptance. Some examples are provided below.

Hirsh 2004, (1). describes several transformations in the electric utility industry where the electrical generating equipment in use at the time reached its technical or social limitations. Of particular interest is his description of the resistance by the utility industry to changing from small, locally sited, and inefficient direct-current (dc) generating power stations of the early 1900s to larger, centrally sited, and more efficient ac generating stations. Similarly, he describes the later resistance to distributed generation as the large plants approached their technical and economic limitations, while smaller-scale technologies, such as gas turbines, steadily improved in both perfomance and cost of operation

One of the classic studies of successful technology diffusion involves the introduction of hybrid seed corn in Iowa by the U.S Department of Agriculture (USDA). Hybrid seed corn had demonstrated greatly improved yields, and, therefore, profits. Yet, it's introduction met with great resistance. The USDA finally won over the farmers by providing hybrid seed to the most influential farmer in the region, assisting him to ensure a good crop, and demonstrating that the new hybrid corn made economic sense. Although this case seem unrelated to the Solar Program at first, anyone involved in solar deployment will soon identify with the experiences of the USDA staff.

The success of technology diffusion rests largely on communication, whether it is through public hearings, workshops, or lectures, or through technical assistance. Rogers (1957) documents a wide range of technologies or ideas that, although commonplace today, may have never successfully reached the marketplace without directed Technology Adoption efforts.

2.2.2 Expert Views about the Future of Solar Technology

Fifty years ago, scientists at Bell Laboratories unveiled the first modern solar cell, using a silicon semiconductor to convert light into electricity. Their demonstration inspired a 1954 New York Times article to predict that solar cells would eventually lead "to the realization of one of mankind's most cherished dreams:- the harnessing of the almost limitless energy of the sun."

Half a century later, solar power generates less than 1 percent of the electricity in the United States, according to Robert Margolis, a senior analyst with the U.S Department of Energy. "Solar energy has been just around the corner for about 30 years," said Joel Makower, a partner in Clean Edge, a Bay Area energy consulting firm, adding the industry's inside joke: "And it's still just around the corner." At the same time, solar advocates say steady advances in manufacturing technology and installation techniques have finally positioned the industry for serious and sustained growth.

"Solar energy power generation is growing 20 percent to 30 percent a year, and that's not shabby," said Roberta Gamble, an energy analyst at Frost & Sullivan, the Palo Alto Market research firm that recently completed a report on the industry.
Daniel Shugar, president of PowerLight, a Berkeley firm that installs solar systems, said the fastest-growing niche in the industry is putting rooftop arrays in business settings, where they can recoup their installation costs in four to eight years.

"Today we're doing systems for half the cost of the systems we did seven years ago." Said Shugar, who is among those who believe solar will eventually live up to its great expectations. "I don't see this as taking another 50 years." Why has it taken solar so long to grow up, and what evidence bolsters advocates' current claims?

The answer to the first question is relatively simple: In an era of cheap fossil fuels, solar cells were at first only economical in remote applications like space satellites, said Bill Yerkes, a 40 year solar industry veteran. "Twenty years went by out of my (work) history with only one real customer, the space program," said Yerkes, who started working with solar cells in 1964 with Boeing Space Division.

As early as 1962, when Bell solar cells powered Telstar, the world's first communications satellite, photovoltaic arrays have been fixtures in pace. But the pace market was small and never created enough demand for solar cells to drive down costs. That's why solar cells remained pricey, while computer chips, their cousins in the semiconductor world, became affordable so fast.

"The space solar business was like making jewelry," said Yerkes, now chief technology officer at Solaicx, a Los Gatos startup working to reduce solar cell costs by improving the process for making silicon. It took the 1973 Arab oil embargo to give solar its first push into the mainstream.

Prompted by the ensuing energy crisis, President Jimmy Carter pushed incentives during the late 70's to promote solar and renewable energy. Environmentalist Denis Hayes, who organized the

first Earth Day event and ran the National Renewable Energy Laboratory in the Carter administration, said he tried to get federal agencies to buy solar cells to create demand.

Hayes, now president of the environmental Bullitt Foundation in Seattle, said it was such government purchases that helped drive down the cost of computer chips. But neither Carter nor his support for solar lasted. Hayes is convinced that if Carter had won re-election and pushed a federal procurement program, solar energy would have reached its current cost by the end of his second term.

Even though federal support for solar diminished after Carter, the industry stayed alive by selling into niche markets like offshore oil rigs and mountain-top relay stations, where even pricey solar cells were the best way to generate electricity. Said Yerkes, who in 1979 helped build the solar cell manufacturing plant in Camarillo (Ventura County), now owned by Shell Solar.

Over the last 20 years, improvements in manufacturing techniques gradually lowered the costs of solar cells. That has widened their use, which in turn has led to further expansions in the market and further economies of scale. "Basically every three years, the overall industry volume doubles, and for every doubling of volume you reduce costs 18 percent, said Tim Woodward, a venture capitalist at Nth Power, a San Francisco firm that invests in energy technologies.

"Right now, this is a real industry that's growing 30 percent a year, said Woodward, whose firm has a stake in Evergreen Solar Incorporation, a Massachusetts company that is developing a new solar cell manufacturing technology.

Manufacturing advances are not the only factor driving solar adoption. In recent years, Japan, Germany and the world's sixth largest economy, California, have fashioned a variety of incentives and policy changes that have made them the centre of the budding solar industry.

In California, two programs have spurred solar adoption: a rebate that helps defray the cost of installing small-to-mid-sized solar arrays and a policy that allows solar users to sell electricity to the utilities.

Called net metering, the latter program has spurred a revolution in solar affordability, said Shugar, the PowerLight President. To understand why, realize that today, the typical solar array is connected to the energy grid, rather than charging batteries, as was the case in the old days, when solar was mainly installed far from power lines, or off-grid. So, during the hottest, brightest part of the day, solar arrays can pump electricity back into the grid, spin the electric meter backward and lower electricity bills, Shugar said.

While some California homeowners have taken advantage of these incentives to install solar arrays, Shugar said, the program appeals mainly to businesses. They can afford the installation costs and have the patience to wait for the payback – free or cheaper energy once the initial investment is recouped.

According to Frost & Sullivan, these incentives have reinforced California's role as the U.S leader in solar energy installation. At the international level, though, the United States is lagging Japan and Germany, which offer more aggressive incentives to install solar. Various estimates say Japan has 40 percent of the world's installed solar cells, followed by Germany with 20 percent and the United Stats with 12 percent.

Hayes, the environmentalist, says Japanese and German government support gives manufacturers an edge in what could become one of the growth industries of the future. "Someone is going to do for photovoltaics what Henry Ford did for automobiles, and it pains me deeply that, at this moment, it seems extremely unlikely that someone is going to be an American," Hayes said.

But T. J. Rodgers, chief executive of Cypress Semiconductor and a survivor of the 1980s chip wars with Japan, said his firm is helping create what will be one of the world's largest solar cell manufacturing plants. Rodgers, whose firm makes special-purpose electronic chips, explained how Cypress detoured into solar.

In 2001, when it was building a new headquarters in San Jose, he decided to install a rooftop solar array capable of generating about half of the building's expected power. He figured that

after seven years, the array would recoup its installation cost and thereafter deliver most of the building's power for free.

Not long after, Rodgers ran into an old Stanford pal, Richard Swanson, who had founded SunPower Corp. in Sunnyvale. Swanson told Rodgers that SunPower was making solar cells that were 20 percent efficient, meaning they converted 20 percent of light into electricity – making them superior to the 14 percent efficient cells on Cypress' roof.

Swanson also said that Sun Power was running out of money and on the verge of laying off half its staff. "It was around Christmas," said Rodgers, who was so intrigued he met with Swanson over the holidays, reviewed SunPower's business plan and made a personal investment to tide the firm over until he could convene Cypress' investment committee.
The upshot was that Cypress bought 57 percent of SunPower in 2002 and is buying the rest and making it a wholly owned subsidiary. With Cypress' backing, SunPower is building a solar cell assembly plant in Manilla.

"By the time we get everything done, we will have bet $100 million," said Rodgers.

Such investments by hard-nosed industrialists encourage longtime solar advocates like the Rocky Mountain Institute's Amory Lovins, whose 1979 book "Soft Energy Paths" urged the adoption of decentralized energy systems solar arrays.

In 15 years, it should be routine for new commercial buildings to make most or all of their power," said Lovins. "Today, a few merchant home builders provide solar power as an option. But they're starting to introduce it as standard equipment."

Meanwhile, for those sick of promises and wondering what solar cells have done for them lately, David Bishop, research vice president for Bell Labs, said one need look no further than the fiber-optic Internet.

Working in conjunction with another Bell invention, the laser, "The solar cell is the heart of all optical communication," he said.

Conceptually, it's simple. Electronic data from computers are routed to a laser, which converts the information to protons and pumps them through glass filaments. At the receiving end, a charge-coupled device – an invention that operates on the same principle as the solar cell - converts those protons back into electrons and electronic data. So if the solar cell hasn't lived up to its energy-producing promise it has played a vital role in creating the fibre-optic network "that can let any human being talk to any human being anywhere," Bishop said.

Highlights, Here comes the sun, Global trend in solar installation.

- 1945: On April 25, Bell Labs unveils a solar battery that converts light into electricity.
- 1962: 3,600 solar batteries power the world's first communications satellite, Telstar.
- 1969: Bell scientists adapt solar principles to translate electronic data into light energy, leading to the charge-coupled device, or CCD, now used in digital cameras and the Internet.
- 1973: Arab oil embargo shocks the U.S economy and awakens interest in solar energy.
- 1976: Solar power estimated to cost $55 per peak watt. Incoming President Jimmy Carter pushes short-lived subsidies to kick-start industry.
- 1984: Solar power estimated to cost $12.26 per peak watt.
- 1992: The United States leads the world in total power derived from solar cells, generating 43,500 kWp (kilowatts at peak), followed by Japan with 19,000 kWp and German with 5,619 kWp.
- 1997: Japan takes the lead with 91,300 kWp of installed solar power, passing the United States with 88,200 kWp and Germany with 41,890 kWp.
- 2001: Japan expands its lead with 636,842 kWp of installed solar power, while Germany's 260,600 kWp passes the United States' 167,800 kWp. Demand pushes solar power's estimated cost down to $3.50 per peak watt.

In developing African countries, South Africa leads the rest in the adoption of Solar technology according to FAO Baseline (1994). User acceptance of solar technology in developing countries has been frequently insufficient or totally lacking. A few years ago, no comparative information on the user acceptance of different solar panels was available and it is still not clear what type of solar panel is accepted best in any given situation.

The successful dissemination of solar panel from production to household is a complex undertaking which involves many actors with various tasks. The researcher set out to study the factors influencing the adoption of solar technology by a variety of end-users in Katulani sub-location of Kitui District.

According to Hawkings 1989, solar energy has been used widely. In Kenya today, solar energy plays a major role in the economy, for example, some agricultural industry rely on solar energy to dry their products, such as coffee, maize, sisal and brick makers dry their bricks using solar. Other uses of solar energy include, solar water heaters, solar still, solar cooker and solar electric devices among others.

Solar energy has therefore gained wide appeal and efficacy in Kenya's economy. This study seeks to establish the extent to which Katulani sub-location has taken advantage of this readily available energy sources.

2.3 Major Variables /Attributes Influencing Adoption of Solar Energy

According to Rodgers and Kincaid (1981), O'sullivan (1978), Daines (1975), Gruening (1991), Brown and Dearl (1967). adoption of technology is influenced by the following variables which will be investigated and examined to identify the extent to which they have influenced the rate of adoption in the area under study.

These variable may seem to be unrelated at first glance yet they have many challenges in common, they have, the goal of accelerating the adoption of solar technologies, increase understanding and improve expectation of the customer and the users and above all provide valuable market related information. In Katulani sub-location, this view examines that processes,

social and other factors Influencing adoption/diffusion of solar technology. Attributes of solar technology that differ from those of traditional technologies and that modify the adoption and diffusion processes are discussed as characteristics of potential adopters and strategy that contribute to successful technology adoption and integration within Katulani sub-location as below:

1. Communication

(i) Mass media exposure and the use of appropriate channels .The message goes through source to receiver. The essential elements in the communication process are source, message , channel, and the receiver . According to social interaction model mass media channel are usually more effective in creating awareness of the innovation whereas interpersonal channels are more effective in forming and changing attitude towards the innovation.

(ii) Change agents promotional efforts – The proportion of individuals that have previously adopted the innovation, Increases the volume of information about and experience with the innovation. This has an effect of reducing the risk in adopting the innovation by the other member of a social unit.

(iii) Early adopters/opinion leaders. According to Rogers and Shoemarker (1971) early adopters are more integrated part of the local social system than other innovators. This group more then any other has the greatest degree opinion of leadership in most social system and peer respect. Opinion leadership is defined as the degree to which an individual is able to informally influence other individuals attitudes or overt behaviour in a desired way with relative frequency. Therefore potential adopter look to early adopters for advice and information about new technology or innovation. Early adopter serve as role models for among other members o a social system.

(iv) The level of information (knowledge about the innovation). This has to do with what information individuals receive, through which channels and then how does that information influence their decision making about adoption.

2. Individual's social- psychology

(i) Values-perceived profitability of an innovation rises, economic theory and common sense suggest that the innovation is more likely to be adopted.

(ii) Social psychological needs. According to Havelock (1974), the individual needs (economic, social, self-actualization and ability to control the environment etc) are the mechanism which lead to specific behaviors such as adoption of an innovation. The social environmental determinants are relevant to the extent that they influence the personality process and predispositions.

(iii) Motivation. These are perceived stimulus inducement that encourage new individual to adopt new idea or technology.

3. Individual's social economic and demographic characteristics

(i) SES – This has to do with the class, income, education and occupation of the individual adopting the innovation.

(ii) Resources – the adoption of innovation is a function of the availability resources such as capital and skills

(iii) Ability to process information – This is basically a functional of the level of education and level of awareness.

(iv) Demographic – This has to do with age and sex. There are certain classes of investment that go with age and sex.

(v) Previous success in adopting other innovations – individuals who have succeeded in adopting other innovation will be willing to adopt other innovation. This success reinforces continuity or sustainability in adoption.

4. Micro-level social structure

(i) Degree and patterns of community integration-the groups influence on innovative behaviour (positive or negative) on the individual is more effective where the group is more integrated or has a high degree of cohesiveness.

(ii) Local community satisfaction. The structure of communication networks has a direct effect that new idea will spread more quickly where individuals are highly connected as opposed to where members are divided into cliques or faction.

(iii) Community norms; the personal communication network of an individual has also been found to have an important influence on behaviour in that the individual is more likely to be influence by the norms of ones community as note by (Rogers and Kincid 1981) elsewhere.

(iv) Communication networks – Interpersonal communication networks influence individuals by determining the necessity of innovation and providing social support to he member for the network for the decision to adopt or reflect the innovation.

(v) Social groups or group dynamics approach. This perspective view the individual as a social with intimate dependence or others for knowledge and decisions on his attitude and actions. The groups one belongs to, identifies with, or even avoids joining are important in sharing beliefs, attitudes and behaviour.

(vi) Role prescriptions

Role prescriptions specifies how people are supposed to behaviour in carrying out their assigned roles. This serves as structuring influence on the nature of reciprocals exchange (Bandura 1977).

Diffusion effects. This refers to the effects the diffusion will have in the lifes of the people adopting the technology. In situation where the technology is proclaimed to improve the lifes of the people may produce a stimulus to adopt the innovation, particularly where profitability is difficult to explain.

5. Macro-Level social structure

(i) Government polices and technologies. These play a very vital rile in promoting an innovation through:

— Provision of conducive environment to governing innovation.

— Financing the expansion of scientific knowledge and technical opportunities.

— Government preference to legitimize and encourage innovations.

(ii) Distribution resources- this in terms of wealth and power faster innovation.

(iii) Social satisfaction.

(iv) Pattern and structure or economic, social and political institutions

(v) State of technological development,

(vi) Early adopters/opinion leaders

(vii) Level of information (knowledge about the innovation)

6. Attributes of the Innovation

(i) Technical credibility – in terms of performance

(ii) Cost-effectiveness relative advantages

(iii) Size of investment required to acquire the innovation-cost

(iv) Complexity – the degree to which an innovation is perceived is relatively difficulty to understand and use.

(v) Compatibility – easy to match

(vi) Triability – the degree to which an innovation may be experiment on with a limited basis.

(vii) Observability – degree to which the results are visible to other

(viii) Perceived social, economic and environmental risks

(ix) "Adopter-peer" satisfaction with the innovation

(x) "Non-adopters-peer" opinion of the innovation

(xi) Extent to which the innovation can solve the individual's perceived problems/needs

(xii) Number of years of useful life left in the technology being replaced

2.4 Technology Adoption/Diffusion

Since early in this century, various "new" educational technologies have been touted as the revolutionary pedagogical wave of the future. Classroom films, programmed learning devices, language laboratories, educational television, computer-assisted instruction and, more recently, interactive videodisc technology have been adopted and integrated into the curriculum with varying degrees of success. Each technology was widely perceived as meeting a need, and each gained a measure of initial commitment of resources followed what has been termed the "traditional model," a "top-down" process in which administrative "mandate" introduced the technology and administrative perceptions, decisions and strategies drove adoption and diffusion. Successful adoption was highly dependent on the degree, stability and wisdom of administrative sponsorship.

None of these technologies, however, has been generally available for individual or private use due to cost, scope or application. This deterred a "grass roots" technology adoption cycles as it was nearly impossible to generate movement from the bottom up by influencing faculty peers and administrators with demonstrations of successful applications.

Today' educational generation, however, sees personal computers, the Internet and the World Wide Web as technology's new wave. Proponents of distributed learning environments and distance learning on the World Wide Web forecast dramatic innovation at all levels and in all areas of education. And although this enthusiasm is reminiscent of that past innovators, there are significant differences in the nature of this technology revolution in education and that of earlier ones with corresponding implications for adoption and diffusion.

Unlike most earlier technologies which were thrust upon the education community, Internet technology is individually available to faculty and students who can use their own systems to serve their own purposes. The impetus for the innovation frequently grows from individual users of the technology, and as their communication and influence moves laterally through their contacts, a body of support can grow and exert "pressure" on the institutional administration to commit to adoption of the technology. There is, therefore, a high potential for a bottom-up" or "grass roots" adoption process to succeed.

Indeed, Everett Rogers (1986), considered by many the "guru" of adoption/diffusion research since publishing Diffusion of Innovations (now in its fourth edition) in 1960, reveals three important ways in which the adoption of interactive communications differs from that of previous innovations. (1) A critical mass of adopters is needed to convince the "mainstream" teachers of the technology's efficacy. (2) Regular and frequent use is necessary to ensure success of the diffusion effort. (3) Internet technology is a tool that can be applied in different ways and for different purposes and is part of a dynamic process that may involve change, modification and reinvention by individual adopters.

2.5 Adoption/Diffusion Theories

The "top-down" and "bottom-up" models of adoption/diffusion provide a directional perspective to the process. Another theory dichotomy relates to the scale of innovation efforts by distinguishing between **macro-level theories** and **micro-level theories.** Macro-level theories focus on the institution and systematic change initiative. Innovation typically involves broad aspects of curriculum and instruction and might encompass a wide range of technologies and practices. Micro-level theories, on the other hand, focus on the individual adopters and a specific innovation or product rather than on large-scale change.

Rogers (1995) recently presented four additional adoption/diffusion theories.

Innovation Decision Process theory. Potential adopters of a technology progress over time through five stages in the diffusion process. Fist, they must learn about the innovation **(knowledge);** second, they must be persuaded of the value of the innovation **(persuasion);** they then must decide to adopt it **(decision);** the innovation must then be implemented **(implementation);** and finally, the decision must be affirmed or rejected **(confirmation).** The focus is on the user or adopter.

Individual Innovativeness theory. Individuals who are risk takers or otherwise innovative will adopt an innovation earlier in the continuum of adoption/diffusion.

Rate of Adoption theory. Diffusion takes place over time with innovations going through a slow, gradual growth period, followed by dramatic and rapid growth, an then a gradual stabilization and finally a decline.

Perceived Attributes theory. There are five attributes upon which an innovation is judged: that it can be tried out **(trialability),** that results can be observed **(observability),** that it has an advantage over the innovations or the present circumstance **(relative advantage),** that it is not overly complex to learn or use **(complexity),** that it fits in or is compatible with the circumstances into which it will be adopted **(compatibility).**

Each of the above can be considered in the context of either a top-down or a bottom-up adoption/diffusion process and in either macro-level or micro-reforms. But there is one other adoption/diffusion theory dichotomy that is relevant to the discussion of Solar innovation. The distinction is between a **determinist (developer-based)** focus and an **instrumentalist (adopter-based)** one.

Determinists regard technology as the primary cause of social change. The process is seen as a series of revolutionary advances that are though to be out of direct human control. Consequently, focus is on an innovation's technical characteristics. Successful adoption/diffusion is the assumed result of an innovation's technological superiority. The innovation's developer is viewed as the primary change agent.

For instrumentalists the process is evolutionary, and the cause of change are in social conditions and in human aspirations for change and improvement. Thus their focus is on the user (adopter) of a technology and its value as a tool to bring about desired change. Human context in which it will be used and the function that it will serve.

2.6 Differentiation of Technology Adopters

The traditional adoption/diffusion continuum recognizes five categories of participants: (1) innovators who tend to be experimentalists and "techies" interested in technology itself; (2) early adopters who may be technically sophisticated and interested in technology for solving professional and academic problems; (3) early majority who are pragmatists and constitute the first part of the mainstream; (4) late majority who are less comfortable with technology and are the skeptical second half of the mainstream; (5) laggards who may never adopt technology and may be antagonistic and critical of its use by others. The distribution of these groups within an adopter population typically follows the familiar bell-shaped curve.

Moore (1991), sees these groups as significantly different (markets" in the "selling" of an innovation to faculty adopters. He suggests that the transition from the early adopters to the early majority – one that is essential to an innovation's success – offers particular potential for breakdown because the differences between the two groups are so striking (See table 1).

Early Adopters	Early Majority
➢ Technology focused ➢ Proponents of revolutionary change ➢ Visionary users ➢ Project oriented ➢ Willing to take risks ➢ Willing to experiment ➢ Individually self sufficient ➢ Tend to communicate horizontally (focused across disciplines)	➢ Not technically focused ➢ Proponents of evolutionary change ➢ Pragmatic users ➢ Process oriented ➢ Averse to taking risks ➢ Look for proven applications ➢ May require support ➢ Tend to communicate vertically (focused within a discipline)

Table 1 (Adapted from Geoghegan, 1994).

2.7 Need-based Diffusion Strategies

Addressing the needs implied by the early adopter-early majority differences when designing diffusion strategies can greatly enhance the likelihood that a technology will be successfully integrated into the curriculum by groups beyond the innovators and early adopters (Geoghegan, 1994).

Need for recognition and process involvement. The chances of successfully "selling" an innovation to the pragmatic early majority will significantly increase if their differences are addressed in terms of their perceptions and needs. They should be recognized as a distinct group within the community and made a part of the planning and policy making process. Attempts to "convert" them to the point of view of the innovators and early adopters are likely to be futile, not to mention almost certainly disastrous to impose the technology on them otherwise. Diffusion of the innovation to the late majority and laggards is more likely to occur through this early majority involvement since the vertical lines of communication between the three groups are more direct than with the innovators and early adopters.

Need for vertical support structure to overcome technophobia. When technology adoption begins from the grass roots, innovators and early adopters, with their strong technology orientation, may be able to get by on their own initiative. Narrowly focused technical support staff may not pose a threat or discouragement to them and their needs for initial training and support may be relatively easy to accommodate. Members of the early majority, however, tend to have no interest in the technology per se and some may exhibit a form of technophobia. Their introduction to the technology should be related to their perceived program and process needs. Since they tend to focus vertically within a discipline, training and support provided by staff who enjoy discipline/content credibility will likely be best received. Correspondingly, such training and support will be more transferable to the late majority and laggards.

Need for wee-defined purpose or reason. The very existence of a technology may be reason enough for innovators and early adopters to pursue it. Their bent for experimentation and their innate interest in technology may dispose them to adopt it and be consistent with "finding a problem to fit the solution". Members of the early majority (and the others by extension), however, tend to derive their purposes from problems related to their disciplines. If the innovation can be demonstrated as an effective, efficient and easily applied solution to those focused needs, it is more likely to be adopted and integrated into the program.

Need for ease of use and low risk of failure. The early majority's aversion to risk quite naturally translates into a need for ease of use and early success if they are to adopt and diffuse the technology. The overlap with support and training requirements is obvious.

Need for institutional/administrative advocacy and commitment. In the top-down adoption effort, institutional sponsorship and support is given. The innovation may be mandated and grant moneys or other funds are committed. Without advocacy and resource commitment by the institution's "policy setters" and "holders of the purse strings", other issues become moot as the process is likely doomed to stalemate, if not to an early demise. But innovation that occurs from the bottom-up also requires institutional attention, and an administration as an entity (except for some possible rare exceptions) tends to emulate the early majority rather than the innovators and early adopters. And even when an institution initiates an innovation from the top, their

perspective tends to be a pragmatic one based on a problem or need that a given technology promises to alleviate. It may relate to staffing, financing, scheduling, teaching, distance or communication. In any case, the mindset is similar to that of the early majority and, as always, there is a need for advocacy to occur if the conditions and activities that can promote adoption by the early and late majorities and laggards are to prevail.

Meeting these needs is an essential part of any successful diffusion strategy. From their work at the University of Colorado, Wilson, Ryder, McCahan and Sherry (1996) derived several principles that apply particularly to situations in which students and faculty are introduced to networked learning environments.

First-time success. No one enjoys frustrations or failure. An innovation is most likely to be accepted and integrated by the early and late majorities if success is experienced initially and subsequently built upon. E-mail is typically introduced early on because of its ease of use, and its success is almost guaranteed. It also extends the peer network, both within and outside the institution, thereby magnifying its impacts on adoption and diffusion.

On-going peer support. Complementing the experience of initial success, there should be ample "hand-holding" along the way of integration as other Internet applications are introduced. Live peer support not only serves as assistance and encouragement; it contributes to the person-to-person communication that promotes diffusion throughout the community. In addition to a training cadre of recognized peers, a network of on-line mentors can expand the potential of the support structure to promote the exchange of innovative techniques.

Real task activities. The early and late majorities are pragmatists who see technology in terms of real problem and task solutions. Activities designed to introduce and teach the technology should address those needs. As pointed out earlier, institutional administrations tend to emulate this pragmatic perspective. Solar technology access to information and resources, and its use for intra and inter-institutional communication can address many administrative needs in addition to those of the faculty, as well as establish a well-defined and recognizable need for adopting the technology.

Variety of incentives. Attempts to impose a technology through explicit mandates and requirements, as in the top-down scenario, are not likely to be effective. This is particularly not true with solar technology because the technology is not so generally available to anyone who has a mind to adopt it. Policies and procedures promoting the technology should grow naturally from its application, and incentives for using it likewise should be tied to its practical use. Adoption and diffusion is more likely to occur where incentives and policies encourage a natural acceptance and use of the new technology.

In addition to a strong stable advocacy needed to ensure the conditions necessary for technology adoption and diffusion, training in its technical aspects and application to real needs is crucial to its integration beyond the innovators and early adopters. Time for experimentation and development of applications is essential. Successful peer users are needed to lead its integration into the curriculum. If the technology is perceived as difficult to learn and/or too time consuming to prepare and use, or is in some other way perceived as threatening, it probably will not be used. No amount of administrative force would likely be effective reversing a negative trend. A perception of value in terms of needs/problem solving and academic or other rewards through establishment of policies, incentives, recognition and an on-line presence in the Internet culture and environment need to be nurtured by the institution's administration.

2.8 Case Study of diffusion

2.8.1 The Diffusion of Hybrid seed corn in Two Iowa Communities

One of the most important innovations in agricultural technology during the years preceding World War II was the development of hybrid seed corn. The term hybrid refers to the offspring of any genetically mixed parentage. With respect to a plant, it means the crossing of varieties of unlike genetic constitution by controlled pollination. If the parent plants are appropriately selected, such hybrids can have a vigor and resistance to such factors as drought and disease that are not found in the contributing strains. Just such qualities were present in the hybrid seed corn that was developed in the late 1920s at Iowa State University and at other land-grant institutions. The innovations was then produced and sold to farmers by hybrid seed companies during the depression years of the 1930s.

While such seeds undoubtedly have many advantages, there is one negative feature that must be considered. Hybrid seed does not reproduce. Thus, farmers who had for generations reserved seed from their current crop so as to plant another year could not do so with the hybrid varieties. They had to purchase new seeds for every planting. That, of course, represented a considerable expense – especially during the 1930s, which had been so difficult for farmers. Offsetting this economic disadvantage, however, was the fact that the use of hybrid seed led to much larger crops of better overall quality and with somewhat less risk to the perils of drought. Still, there were these trade-offs, and they came to be important factors as individual farmers considered adoption. Nevertheless, the benefits seemed so clear for the nation's food supply that during the 1930s the U.S. Department of Agriculture (through extension services, experiment stations, and land-grant institutions) increasingly advocated the use of hybrid seed by Midwestern corn farmers.

By virtually any measure, hybrid seed corn was a great success as an agricultural technology. As Bryce Ryan and Neal Gross reported in 1943.

The introduction of hybrid seed corn has been the most striking technical advance in Midwestern agriculture during the past decade. Although a few experiments had been acquainted with this new and studier seed for many years, only since 1937 has it become a nationally important production factor. It has been estimated that between 1933 and 1939 acreage in hybrid corn increased from 40,000 to 24 million acres (about one-fourth of the nation's corn acreage.)

In spite of the fact that the use of this agricultural innovation has spread rapidly among corn growers in many parts of the country, relatively little was known about the process of adoption on an individual basis. By 1939, for example, 75 percent of the farmers in Iowa were planting hybrid seed. Yet no studies had been made why such farmers had altered their traditional practice of saving seed from year to year. What information did they receive, through what channels, and how did this influence their decision making?

A study of the adoption of innovation that is now regarded as a classic is that of Ryan and Gross (1943). The study was designed by Ryan as a means of focusing on hybrid seed corn and its adoption among two groups of farmers in Iowa.

According to Ryan and Gross adoption tended to be on a gradual and almost experimental basis. Few farmers had switched their entire acreage from the older, freely pollinated seed to the new hybrid in a single planting. Most had tried it out on a smaller plot before making the change. The general economic state of the nation may have been an important background factor here. The 1930s were, after all, the years of the Great Depression. Farmers had suffered grievous losses early in the decade, when many could not sell their crops and simply had to let them remain in the fields to rot. Then as the Roosevelt administration developed federal programs to support agriculture, things got better. However, laying out a substantial amount of money for a new kind of seed, even with the promise of a more bountiful harvest, was still a gamble. Thus, the essential conservatism of Midwestern farmers, plus the economic difficulties of the time, held back wholesale and immediate adoption.
How did the innovation come to their attention? A number of different channels were involved. Nearly half cited salesmen from the seed companies as their earliest source of information. About 10 percent learned of its existence from advertisements on the radio. Articles in farm journals accounted for an additional 10-7 percent. Only 14.6 percent named neighbours as their initial source. A few learned from the university's extension service, another small number from relatives and so on.

Not all of these sources were equally important. For example, even though neighbours were not named with great frequency as the origins of their earliest information, they were identified as the most influential source. In the opposite direction, while salesmen were identified as the most frequent source of initial information, they were not as significant as neighbours in their ultimate decision to adopt.

The time factor between first learning and decision to adopt turned out to be a complex one. Generally, there was a gap of several years between the time when farmers first heard of hybrid seed corn and the point at which they actually began to plant it. In fact, there was a modal time

lag of between five and six years between the first hearing of the innovation and actually adopting it. Thus, a lot of farmers knew about hybrid seed corn before they took action to plant it.

There was also a complex relationship between time and the degree to which various interpersonal and media sources were active as channels of information and influential in the adoption decision. Salesmen were clearly the most active sources of information for those who adopted in the early period when farmers were learning of the existence of the new seed (1928 to 1935). And, they were also quite influential among those who adopted early during the first half of those years during which most adoptions were actually made (1935 to 1940). That influence declined sharply during the period, however, and for those who adopted late (after about 1936), salesmen were much less significant in the decision to adopt. Of the interpersonal channels, neighbours were important in two ways. They played an increasingly significant role in bringing the seed to the attention of adopters during the early 1930s, and they became increasingly influential throughout the years when the new seed was actually being adopted. Indeed, they were far more influential than salesmen during the last half of the 1030s. Mass media, such as farm journals and radio advertising, were clearly not as important in the adoption of this particular innovation as interpersonal contacts. However, both played some part in bringing the innovation to the attention of the respondents, particularly before 1935.

Clearly, the process of interaction identified by Ryan and Gross as underlying the acquisition of this agricultural technology did not fit the assumptions of random activity suggested by Pemberton. That is, the idea that salesmen, county extension agents, relatives, mass communicators, or other parties mentioned were in some form of chance-like interpersonal contact with the farmers under study does not make sense. Indeed, what they described was a web of relatively orderly social and media contacts, in which established patterns of social interaction with neighbours and salesmen, plus attention to mass communications, played the central roles in creating awareness of the innovation and defining it as important on the part of those who would adopt it.

It was that finding, that the adoption of innovation depends on some combination of well-established interpersonal ties and habitual exposure to mass communication, that made the Ryan and Gross study important. It became a milestone not because it revealed how a particular kind of corn seed came to be used by farmers in Iowa but in part because it moved attention from pattern to process in the study of the adoption of innovation as a basis for social change. Tarde had tried to identify that process in 1890 but was not able to do so, given the undeveloped state of sociology and psychology. By 1943, however, the social sciences were ready to incorporate the process of adoption of innovation on an individual basis into the general body of concepts important to the study of social change.

For students of mass communication, the study provided a foundation and conceptual framework for understanding the link between awareness of something new – often through information supplied by mass media-and action resulting in some form of adoption. Adoption might mean purchases of an advertised product, changes of beliefs advocated by an information campaign, modifications of attitudes brought about by persistent relations efforts, or other changes in behaviour in which mass communications played a role.

As additional studies of adoption of innovation were undertaken, the boundaries between studies of the acquisition of new technology and the study of influences of mass communication began to blur. By the early 1960s, interest in research on the spread of innovations had sored. In 1962, Everett Rogers reviewed 506 studies of the process in his definitive work on the process and effects of the diffusion of innovations. The innovations under study by that time included medical practices, agricultural technology, educational changes, birth control methods, consumer products, manufacturing techniques and a variety of other inventions and changes.
As the focus of scholarship broadened from pattern to process, efforts were increasingly made to understand the nature and sequences involved when individuals made decisions to acquire and use something new. One result was conceptual clarity. For example, Rodgers defined an innovation in straightforward manner as an idea, practice or object that is perceived as new by individual or other unit of adoption. This definition has significant advantages. For one thing, it makes the perception of the individual the key to what constitutes an innovation. That is, it does not matter whether or not something is in fact "new". It can be regarded as an innovation if it

appears to be new to the adopter. Furthermore, his definition is consistent with the earliest studies of the process in that it appears equally to individual persons (such as farmers) or to other kinds of adopters (such as nations, cities, organizations and other kinds of groups).
Rodgers clarified the work of Ryan and Gross by identifying five major stages in the adoption process. These were awareness, interest, evaluation, trail and finally adoption. In the first stage, the potential adopt learns of the existence of the innovation. It is at this point that the mass media, as well as interpersonal contacts, bring the relevant information to the attention of the potential user. This part of the process was well mapped by Ryan and Gross in their classic study of hybrid seed corn.

Rogers also addressed the question of whether awareness of an innovation is created on a random basis (suggesting the interpretation advanced by Pemberton). The answer is that this seems most likely. For example, becoming aware of hybrid seed corn would have meant little to the average city dweller, even if he or she might have encountered the information by chance. However, it was significant information for a corn farmer in Iowa. Thus, Rogers concludes that awareness is undoubtedly related to some type of need that could potentially be satisfied by the new product or technology.

Once the individual is aware of the innovation, his or her interest may be aroused. If not, the process ends with this second stage. But if interest has been aroused, mass communications as well as interpersonal contacts may play a critical role. That is, interest can lead the individual to search actively in a purposive way for more information about the innovation. As Rogers points out, all of the variables that lead to selective use of media and other information sources become important at this point.

Once the nature of innovation is understood, the third stage becomes important. The individual has to evaluate whether or not it will indeed meet the need that was a necessary condition in the previous stage. Rogers calls this a sort of "mental trial" stage, during which the person decides whether the problem-solving advantages of adopting the innovation outweigh its disadvantages (costs, risks, effort etc.)

In the fourth, or trial stage, the innovation is actually used. If possible, this is done on a small scale. This was clearly the case among the Iowa farmers, who often planted a small part of their acreage in the new corn so as to compare it with what they had been doing. But for many innovations, small-scale trials may not be possible. In some cases. The new item can be used temporarily before a final decision is made. Taking a test drive in a new car before a final purchase decision is made would be one example. If small scale or temporary use is possible, many potential adopters pass through this trial stage.

The final stage is actual adoption. The individual has made a decision and the new item is acquired. Presumably, it continues to be used on a more or less permanent basis. The individual becomes a part of the population who has adopted, and he or she is added to the S-shaped curve.

An additional line of inquiry opened by Ryan and Gross study was a concern with the difference between types of people who adopted the innovation at various points along the accumulating curve. Distinctions were discussed between what they called "early acceptors" (true innovators who were the very first to try out the new seed, "early adopters" (a slight larger number who began using after seeing it demonstrated by the early acceptors), the "majority" (who adopted in large numbers between 1940 and 1941), and "later acceptors" (who did not take up the innovation until most of their neighbours were already using it). Thus, in addition to the shift from pattern to process as a major emphasis, as discussed earlier, the hybrid seed corn study also identified types of people as a focus of concern.

In later year, differences between types of people in terms of categories of adopters came to be exhaustively studied. For example, Rogers brought together the pattern, the process, and the types of people into a synthesis of adopter categories on the basis of a personality trait of "innovativeness."

Rogers (1983) also defined diffusion in a way that identified the major related concepts. Essentially, he maintained, it is the process by which an innovation is communicated through certain channels over time among the members of a social system. As the hybrid seed corn study (and earlier research) indicated, as this process takes place, some sort of S-shaped adoption curve

describes the proportion of a relevant population of potential adopting units who have taken up the time at various points in time. However, as research accumulated, it became clear that different types of innovations diffuse at different rates. This creates a family of different-appearing curves. For example, some innovations may sweep through a set of adopters rather swiftly. Thus, the pattern of adoption (swift or slow) that will be followed by any particular innovation will depend on the particular trait and the characteristics of the social system, as well as the types of people who become aware of this existence and potential value for the purposes. The Ryan and Gross study focused attention on the major factors involved in the adoption of innovation: (1) a specific innovation, (2) processes of interpersonal and mass communication that created awareness of the item, (3) a specific kind of social system, and (4) different types of individuals who made decisions at various stages as use of the item diffused. Furthermore, it provided a pivotal point at which scholarly interest began to shift from an almost exclusive concern with the pattern formed by the adoption in a population over time to the behaviour involved in the process of adoption.

For the study of mass communication, an important point concerning the hybrid seed corn study covers the relative role played by media versus that of interpersonal channels in creating awareness. Actually, the Ryan and Gross study emphasized diffusion as a sociological phenomenon. That is, the research did not show that mass communications were particularly important, either in informing the relevant population about the innovation or in persuading them to adopt it. For many other kinds of innovations today, that would not be the case; the media would be far more significant. The reason that mass communications played a relatively minor part in the diffusion of the adoption of the hybrid seed corn in Iowa at the time is that the setting was a rural environment closely resembling a traditional society where word-of-mouth communication channels were more important. Moreover, it was not the kind of innovation that would normally be advertised via the common mass media that were operative at the time. Thus, among the farmers studied, interpersonal channels (salesmen and neighbours) were far more important in bringing the innovation to the attention of potential adopters than were radio, movies, magazines or newspapers.

In pointing to the role of interpersonal communications, the Ryan and Gross study parallels what was independently found by Lazarsfeld and his associates in the discovery of the two-step flow process in the very different setting of the People's Choice and by Katz and Lazarsfeld later in their research on personal influence in still another setting.

In a more urban setting, then or now, where one's neighbours may be total strangers, one would seldom expect to receive a great deal of information about an innovation by word-of-mouth channels. For some, family and friends may play a part; neighbours may not be so important. People may live in the same building, but contacts between them tend to be far less frequent than between families living on adjacent farms. Indeed, in cities there may be no contact with neighbours at all. Moreover, salespeople do not have the same access to residents in urban environments as they have with rural populations.

Overall, for city dwellers the mass media are undoubtedly far more significant as sources of first learning of almost any new idea, product, or service. People hear of a new soft drink or laxative from advertisements on television; they find out about a new model of a fishing rod or kind of computer software from magazines devoted to their interests; they learn of a new hairstyle or slang expression in a movie. Even an innovation related to their occupation or business will usually come to their attention via a newsletter or specialty magazine rather than from neighbours or from family friends. Thus, the ratio between interpersonal and mass media channels is likely to be drastically reversed for most innovations adopted in more urban settings.

Nevertheless, the study of hybrid seed corn set the stage for a floor or research that greatly expanded our understanding of the process of the adoption of innovations of all kinds, regardless of whether those who consider the new trait first learned by interpersonal channels or via the mass media. The important points revealed by the Ryan and Gross study were the ideas of stages in the adoption process, the different categories of adopters, and the channels by which they receive different influences from various sources. These contributions remain as an important conceptualization of the way in which new traits spread through a relevant population of adopting units.

Finally, Rogers estimated that by September 1993, more than 5,000 studies of the diffusion process and their patterns over time had been published. Studies of the adoption of innovations have been widely pursued in such fields as national development, public health, geography, marketing, the adoption of media technologies, changes in manufacturing processes, educational innovations, new government policies and dozens of others. Clearly, the modest study of ways in which farmers in two communities in Iowa had adopted a new kind of hybrid seed corn has had a profound intellectual impact in understanding the role of mass communication in this kind of social and cultural change.

2.9 Analysis of Diffusion Models and Concepts

2.9.1 Marketing Diffusion Models

Although several models can be grouped as marketing diffusion models, this study will concentrate on three of the major marketing diffusion models: (1) the market penetration model, (2) the substitution model and (3) the rate of imitation model.

Market penetration models are aimed at predicting the diffusion pattern of new technology in the market and are usually expressed by an S-shaped logistic curve (Fisher and Pry, 1971). Basically, these market penetration curves translate the results of the economic comparison to the percentage of market participants who will use (purchase) the innovation.

The main assumption of the market penetration curve is that if the cost and utility comparisons do not reach some minimal level, the technology will not be adopted (Stern and others, 1975). The S-shape of the curve reflects the fact that when the cost comparisons are marginally favourable, only a few innovators will adopt the technology. The majority of adoptions come when the technology demonstrates clear economic and technical advantage in comparison to its substitutes. The rate of penetration then slows as the technology matures and the majority of the market is captured.

In addition, market penetration models offer a system of assessing and predicting the relative impact of interventions, such as government incentives, on the diffusion of innovations. According to Schiffel and others (1978), the investigation of incentives usually starts by translating the incentives into a change in costs and then determining effects on the model

outputs. Thus the difference between the baseline results and the recalculated values is attributed to the incentive.

The major contributions of market penetration models to understanding the diffusion process are (1) explaining the influence of competing innovations in terms of cost and utility comparisons, and (2) offering a system of assessing and predicting the impact of interventions such as government incentives on the diffusion of innovations.

The substitution model, on the other hand, is basically an extension of the market penetration model and is based on projecting the S-shaped curve. Stern and others (1975) developed this model for forecasting the course of market penetration where a new product or technology competes with and gradually supplants an older one.

The general argument of the model is that the "path" of substitution (i.e.), the percentage of the market acquired by the new product as a function of time) tends to take the form of an elongated S-shaped curve. The slope of the curve before the first inflection point is rather flat, reflecting the fact that during the first few years of a new product, the diffusion product must overcome factors such as the "ignorance" or resistance of customers; performance "buggs" in early models; contract arrangements based on the old technology; product diseconomies due to small scale; problems of financing development; and installing and learning to use new processing equipment and methods. In Katulani sub-location, these initial teething problems seem to be the ones slowing the adoption rate of solar technology.

During later phases of substitution, the rate of increase of market penetration increases sharply as the product becomes accepted, as production processes are improved, as economies of scale are achieved, as new contracts are made, and as the "learning period" for the industry comes to an end. Finally, after the inflection point, the curve flattens again. The new product is no longer changing rapidly and has already exploited most of its economies of scale. It is also now challenging the "defender" mainly in those markets or applications for which the latter is best suited.

The major contribution of the substitution model to the understanding of the diffusion process is that the diffusion rate of an innovation is a function of (1) the level of the innovation's technological development, (2) the role of supporting institutions such as marketing and credit organizations, and (3) the customers' level of knowledge or information about the innovation. In the area under study, all these factors which help improve the rate of adoption seem to be lacking thereby contributing the low rate of adoption of solar technology.

Although Manfield's (1977) rate of imitation model deals more specifically with firms, most of its premises can also appropriately be extended to explain individual innovative behaviour. At the individual level, the model would predict that the number of individuals adopting an innovation in a given period is a function of several factors such as.

(1) The proportion of individuals that have previously adopted the innovation; the argument is that the number of previous adopters increases the volume of information about and experience with the innovation, thereby reducing the risk in adopting it, a process usually referred to as "word-of-mouth advertising."

(2) Adoption of the innovation by competitors; this may produce a stimulus to adopt the innovation, particularly where profitability is difficult to explain.

(3) The profitability of adopting the innovation; as the perceived profitability of an innovation rises, economic theory and common sense suggest that the innovation is more likely to be adopted.

(4) The size of the investment needed to acquire and install the innovation; other things being equal, an innovation which requires a relatively small investment will diffuse faster than one requiring a large investment because it represents less financial risk.

(5) The number of years of useful life left in the product or technology being replaced; most people are likely to continue using the technology to be replaced" if it is still in good condition, particularly when dealing with costly innovations. Thus, the state of the technology to be replaced may determine when one is going to adopt the innovation regardless of the individual's general degree of innovativeness or the cost effectiveness of the new technology.

In summary, the marketing models of diffusion considered in the present study explain the diffusion process mainly in terms of the innovation's costs, the relative cost and utility of the innovation (cost-effectiveness), the level of the innovation's technological development, the role of supporting institutions, the customer's level of knowledge or information about the innovation, including word-of-mouth advertising, and adoption of the innovation by competitors and the mount of useful life left in the technology being replaced. In addition, the market penetration models offer a system of assessing and predicting the impact of interventions, such as government incentives, on the diffusion process. A summary of factors influencing the diffusion process is presented in Figure 1 below.

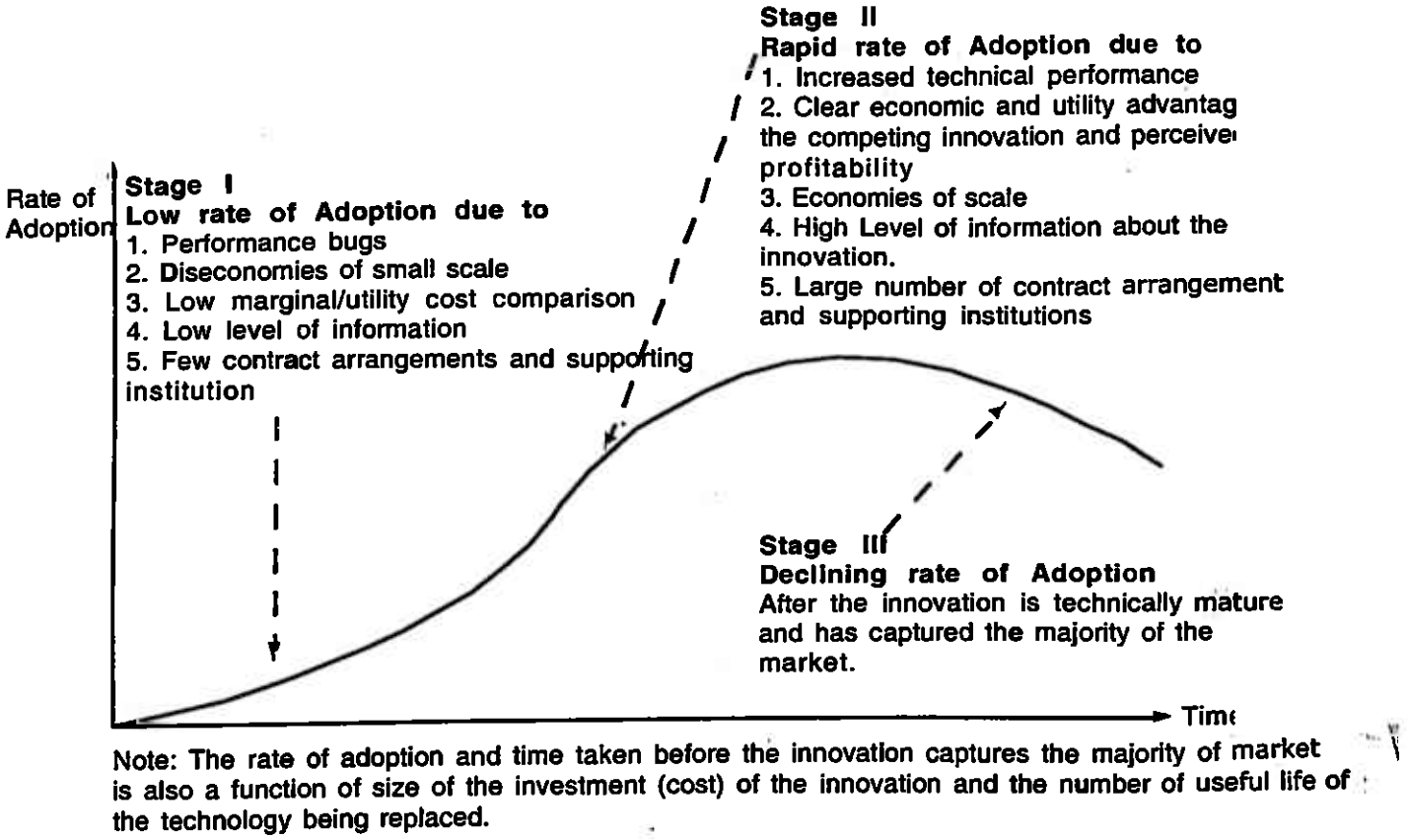


Fig. 1: Factors influencing diffusion process

However, market diffusion models do have some severe limitations in explaining the diffusion process. For example, most of the models assume that competitiveness produces market acceptance. However, the problem here is one of the diffusion of innovations. The excellence of an innovation in terms of cost-effectiveness in an ideal setting does not guarantee its successful

diffusion. More often there are many other factors influencing the acceptance of a new technology. For example, supply problems in the technology delivery systems, which usually exist for a new technology, and non-economic incentives or motivations, such as concern for the environment and conservation of energy, are not considered in the models. Furthermore, theoretical knowledge of why and which individuals do or do not invest in a new technology is not considered. Finally, these models do not usually include behavioural theories in their predictions, and neither do they explain their S-curves on a theoretical based cause and effect relationship.

This model is useful in understanding the adoption of solar technology in Katulani sub-location because the innovative idea involves selling. The variables in the promotion of the product solar energy is paart of the product needs. The behaviour of the people in response to the idea is dedicated by the forces of demand and supply. This therefore makes the model critical/useful in understanding the rate of adoption of solar technology in Katulani sub-location.

2.9.2 Social Psychological Models

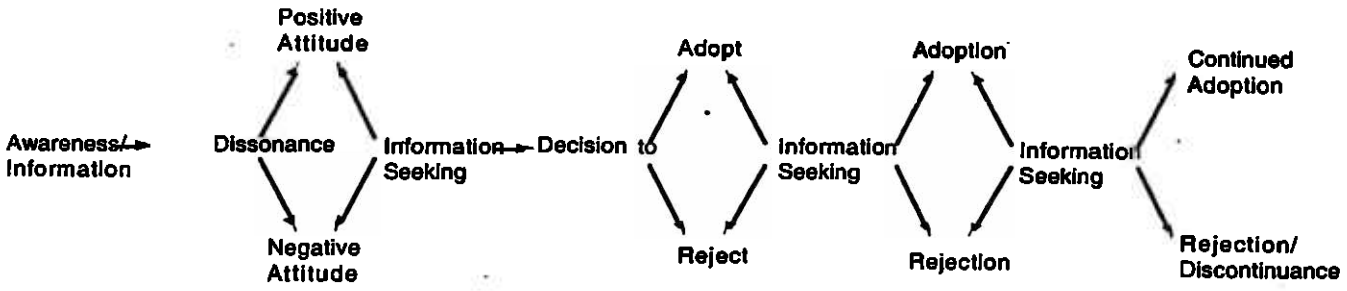
Most social psychological models explain the diffusion of innovations in terms of personality processes and pre-dispositions such as needs, motivations, values, attitudes, ego-defence and cognitive traits. In these models, social environmental determinants are relevant to the extent that they influence the personality processes and predispositions/attitudes.
These personality pre-dispositions were examined in the study of the adoption of solar technology in Katulani sub-location to evaluate how they may have influenced the adoption rate.

Thus for example, social psychological models proposed by Havelock (1974) emphasize that the individuals needs (economic, social, self-actualisation, ability to control the environment etc) are the mechanism which lead to specific behaviours, such as adoption of innovations. The model predict the diffusion process as a patterned sequence of activities beginning with a need, sensed and articulated by the individual, which is translated into a problem statement and diagnosis, leading to search and retrieval of information which can be used in formulating or selecting the innovation. Finally, the user needs to concern herself/himself with adopting the innovation,

trying out and evaluating its effectiveness in satisfying his original need. The role of outsiders such as change agents is seen as that of either providing innovations specific to diagnosis or providing guidance in the process of problem solving at any or all the stages.

The concept of how needs influence behaviour can also be extended or explained by the cognitive dissonance theory. Needs can be assumed to be a result of "discrepancy or inconsistency. "Festinger (1957), in his theory of cognitive dissonance, retained the notion that discrepancies or inconsistencies cause tension that people try to reduce or eliminate by bringing their attitudes and their actions into line. When an individual feels dissonant, he will ordinarily be motivated to change his knowledge, his attitude, or his actions. In the case of innovative behaviour. Roger with Schoemaker (1973) suggested that the following occur.

1. The individual becomes aware of a felt need or problem and seeks information about some means, such as innovation, to meet this need. Hence, a receiver's knowledge of a need for innovation can motivate information-seeking activity about the innovation. This occurs at the knowledge stage in the innovation-decision process.
2. The individual becomes aware of a new idea which he regards favourably and is motivated to adopt by the dissonance between what he believes and what he is doing. This behaviour occurs at the decision-making stage in the innovation-decision process.
3. After adopting the innovation, the individual may secure further information which persuades him that he/she should not have adopted. This dissonance may be reduced by discounting the innovation, or, if he originally decided to reject the innovation, the individual may become exposed to pro-innovation messages, causing a state of dissonance which can be reduced by adopting. These types of behaviour (discontinuance or later adoption) occur during the confirmation function in the innovation-decision process.



Note: Individuals usually seek information which is either pro or unit the innovation depending on their initial attitude or towards the innovation. That is, there is a tendency of selective exposure, perception, and forgetting of dissonant info

Fig. 2: Information seeking process

However, according to Rogers and Schoemaker (1971), individuals frequently try to avoid becoming dissonant in their decision to adopt or reject an innovation mainly by seeking only that information which they expect will support or confirm a decision already made, a process known as selective exposure. Similarly, dissonance can be reduced by selective perception (message distortion) and by the selective forgetting of dissonant information.

In solar energy intervention strategies, such perspective has led to the assumption that human beings are rational, guided by reason and knowledge. This assumption has largely been applied in interventions characterized by heavy emphasis on information dissemination, education and communication with strong appeals to individual and social benefits. The rationale for such strategies has been to create dissonance with the hope of leading to adoption as well as for reinforcing continuity or sustainability.

According to Havelock (1974), the problem-solving model is usually seen as a patterned sequence of activities beginning with a need, sensed and articulated by the client, which is translated into a problem statement and diagnosis. When one has thus formulated a problem statement, the client-user is able to conduct a meaningful search and retrieval of ideas and information which can be used in formulating or selecting the innovation. Finally, the user needs to concern himself with adopting the innovation, trying out and evaluating its effectiveness in satisfying one's original need.

The focus of this approach is the individual needs, and what he/she does to satisfy the needs. The role of outsiders is as consultants or collaborators. For example, the outside agent may assist the user either by providing innovations specific to the diagnosis or by providing guidance on the process of problem solving at any or all of the indicated stages.

The models that depict the individual as a psychological machine attempt to account for behaviour by appealing to the concept of "needs". According to Pacanwski (1978), the history of social psychology is a succession of appeals to more and more complex needs. For example, Taylor (1911) believed that individuals were primarily motivated by economic needs. Moreover Roethlisberger and Dickson (1939) argued for the primacy of social needs. Maslow (1954) directed attention to a hierarchy of needs, with the need for self-actualisation being superordinate. Schein (1965) argued that individuals need to be able to control their environment, and, because they face various environments, they have various situations-dependent needs. In these social psychological theories, needs are the mechanisms which lead to specific behaviours.

The concept of how needs influence behaviour can also be extended or explained by the cognitive dissonance theory: Needs can be assumed to be a result of "discrepancy or inconsistence." Festinger (1957), in his theory of cognitive dissonance, retained the notion that discrepancies or inconsistencies cause tension that people try to reduce or eliminate by bringing their actions into line. When an individual feels dissonant, he will ordinarily be motivated to change his knowledge, his attitude, or his actions. In this case of innovative behaviour, Rogers with Schoemaker (1971) suggested that he following occur:

(1) The individual becomes aware of a felt need or problem and seeks information about some means, such as an innovation, to meet this need. Hence, a receiver's knowledge of a need for innovation can motivate information-seeking activity about the innovation. This occurs at the knowledge stage in the innovation-decision process.

(2) The individual becomes aware of a new idea which he/she regards favourably and is motivated to adopt by the dissonance between what he/she believes and what he is doing. This behaviour occurs at the decision stage in the innovation-decision process.

(3) After adopting the innovation, the individual may secure further information which persuades him that he/she should not have adopted. This dissonance may be reduced by discontinuing the innovation, or, if he/she originally decided to reject the innovation, the individual may become exposed to pro-innovation messages, causing a state of dissonance which can be reduced by adoption. These types of behaviour (discontinuance or later adoption) occur during the confirmation function in the innovation-decision process.

However, according to Rogers and Shoemaker (1971), individuals frequently try to avoid becoming dissonant in their decision to adopt or reject an innovation mainly by seeking only that information which they expect will support or confirm a decision already made, a process known as selective perception (message distortion) and by the selective forgetting of dissonant information.

At least three general points can be drawn from the individual needs approach. First, individual need is the motivation or mechanism which leads to specific behaviour, such as the adoption of innovations. Second, the individual's need, whether resulting from economic, social, or other environmental situations or from cognitive dissonance, leads to a search and retrieval of ideas and information which can be used in decision making. For example, the information can be used to select the idea or innovation that can satisfy the original need or discrepancy, or it can be used to bring attitudes and actions into line and hence reduce the uncomfortable state caused by the discrepancy or the need. Third, a state of dissonance is frequently avoided mainly by seeking only that information which is expected to support or confirm a decision already made through a mechanism of selective exposure, perception, and forgetting dissonant information. This model is useful because it helps explains what motivates adoption of solar technology in Katulani sub-location. There is need for alternative source of energy occasioned by the dwindling wood furl, the encroachment of modernism and associated attributes. The changing value system of the people and the rapid spread of cell phones, people require power for charging their mobiles. From the observations made about the solar technology, it appears that people within the area of study have the need of the technology, however,

they don't seem to be aware of its existence, a factor which is influencing the rate of adoption.

2.9.3 Social Interaction Models

Diffusion of Innovations

Many theories, models and concepts in social sciences touch on social interaction processes. However, classical diffusion of innovations by Rogers and Schoemaker (1971) is probably the most comprehensive and widely cited among the social interaction models.

Basically, the model distinguishes four main elements in the diffusion process: (1) the innovation, (2) which is communicated through certain channels, (3) over time, (4) among the members of a social system.

The diffusion model predicts that (1) the diffusion of an innovation in a social unit occurs primarily through communication and interaction between persons, and (2) an innovation is at first adopted only by a few. Others follow and more and more are converted in a snowballing effect. The speed of the innovation process increases, reaches a peak based on the number of members in the social unit, and then declines until finally the last ones are reached. The adopter distribution follows a bell-shaped curved over time and approaches normality. (3) Once a certain section of a social unit (innovators and part of early adopters) have adopted an innovation, it spreads automatically among other members of the system as long as the diffusion process is not interrupted by intervening factors. Thus, the classical diffusion model attaches special importance to persons through whom an innovation finds entry into a social system, particularly the "innovators", and the "early adopters because the potential adopters look to these people for advice and information about the innovation.

According to the model, the important features of an innovation that determine its rate of adoption include: (a) the relative advantage: "the degree to which an innovation is perceived as better than the idea it supersedes; (b) complexity: the degree to which an innovation is perceived as relatively difficulty to understand and use;" (c) triability: "the degree to which an innovation

may be experimented on with a limited basis;" and (d) absorbability: "the degree to which the results of an innovation are visible to others".

According to the model, mass media channels are usually more effective in creating awareness of the innovations, whereas interpersonal channels are more effective in forming and changing attitudes towards the innovations. Most human communication also tends to take place between individuals who are homophilous, that is, individuals who are similar in certain attributes such as beliefs, values, socio-economic status, and the like, than between individuals who are heterophilous, that is, dissimilar in these attributes.

The model also notes that the social structure of a system, which consists of the status or positions and how they are arranged in the system, has an important influence on the speed of diffusion of new ideas. The social structure can impede or facilitate the rate of diffusion and adoption of innovations through system effects. Furthermore, the social norms, socio-status, and hierarchy of a social system influence the behaviour of individual members and consequently their innovative behaviour.

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According to Rogers and Shoemaker (1971), the innovators (the first 2.5 percent of the individuals adopting an innovation) are characterized by eagerness to try new ideas. This interest

leads them out of local circles of peers and into more cosmopolitan social relationships. Communication patterns and friendships among a clique of innovators are common even though the geographical distance between the innovators may be great. Being an innovator also means having control of substantial financial resources to absorb the possible loss due to an unprofitable innovation and the ability to understand and apply complex technological knowledge.

On the other hand, according to Rogers and Shoemaker (1971), early adopters are a more integrated part of the local social system than are innovators. Whereas innovators are cosmopolites, early adopters are localities. This group, more than the others has the greatest degree of opinion leadership in most social systems and peer respect. Opinion leadership is defined as "the degree to which an individual is able to informally influence other individuals' attitudes or overt behaviour in a desired way with relative frequency." Thus, potential adopters look to early adopters for advice and information about the innovation. Furthermore, because early adopters are not too far ahead of the average individual in innovativeness, they serve as a role model for many other members of a social system. Communication behaviour of early adopters also entails significant contact with change agents, more extensive exposure to interpersonal communication channels, a propensity to seek information about innovation, and more contact with science. Factors influencing the rate of adoption of innovations are best summarized in figure 3.

Although the classical diffusion model is probably the most comprehensive diffusion model, it has several methodological, theoretical, and practical limitations. Among the methodological limitations, its inclusion of the time dimension leads to a dependence upon recall data (unless overcome by use of a "before-after" research design, which has been rare in diffusion studies) and to difficulties in determining the time-order of diffusion variables. Secondly, the modes typology of adopters requires two assumptions: (1) that adoption decisions as a function of time are normally distributed, and (2) the diffusion process is relatively complete within the social system at the time of data collection. However, in reality, the normality assumption is rarely met, and diffusion researchers often want to study adopter types in social systems where adoption is significantly less than 100 percent or where the process has not reached equilibrium.

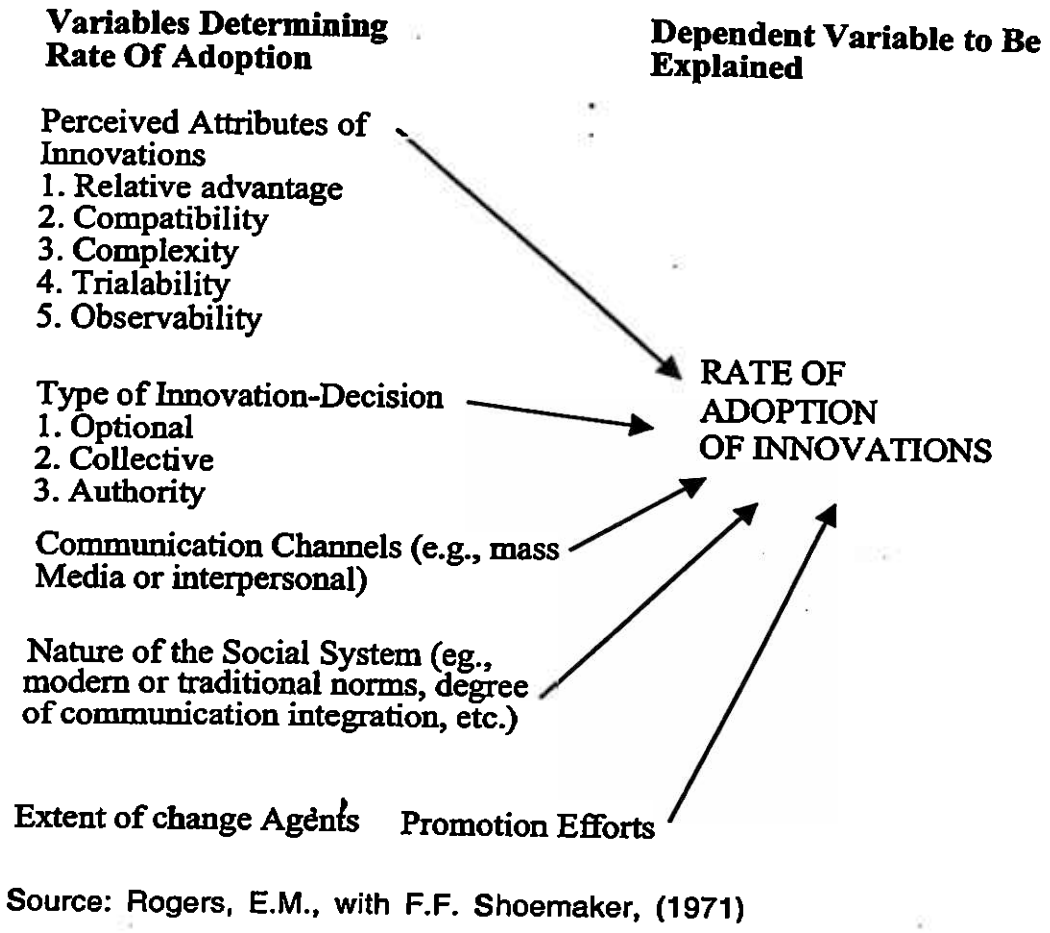


Figure 3 factors influencing the rate of adoption

The first theoretical criticism of the classical diffusion model is over concern with the individual as the unit of analysis and decision-making. This has led to exclusion of group or collective influence including the impact of other forms of intervention, such as government incentives' and overemphasis on individual blame. Today certain scholars increasingly blame the situation rather than the individual for not adopting the innovations (Rogers, 1976; Hirsh, 1076; Beltran, 1976). The situational approach thus tends to emphasize the inherently relational nature of many important phenomena that impinge on the diffusion process. Kranzberg (1966) also cautioned that "If we are to understand the process of technological diffusion, we must regard technology as a cultural, social, psychological and political process as well as the imitation of artifacts." Thus, the manner and rate with which new technology is adopted can not be interpreted independently from the social, economic and political system where the technology is introduced.

The second criticism, according to Rogers (1980), is that most diffusion studies, at least until recent years, have taken a "pro-innovation" position, assuming that the innovation being studied should be adopted by individuals; hence, human communication was viewed mainly as a one-way linear process of persuasion. The individual was assumed to be a passive consumer rather than an active participant in decision-making. However, certain scholars are beginning to describe human communication, including the diffusion of innovation, as information-exchange, a process more in line with a convergence model of communication (Rogers and Kincaid, 1981).

Third, the diffusion model's estimation of the role of communication on the diffusion process has recently been questioned. The main criticism is that, although communication can change the individual's perception about his situation by itself, it cannot change that situation very much (O'Sullivan, 1978; Daines, 1975; Gruening, 1971, Haney, 1969; Brown and Dearl, 1967). In other words, other inputs, particularly resources, must accompany communication before adoption of most innovations will occur.

Finally, since the model attaches special importance to persons through whom an innovation finds entry into a social unit, change agents and policy makers have concentrated their activities on the wealthy (who are usually the innovators or early adopters), with the expectation that adoption of those innovations will trickle down to the majority of people. However, the "trickle-down" process has not functioned for most innovations, particularly those requiring substantial resources.

Although the classical diffusion of innovations is fairly comprehensive, it does not adequately explain some of the predictions it makes on the diffusion of innovations.

It is argued that the diffusion of an innovation in a social unit partly occurs by communication and interaction between persons through the influence of interpersonal communication networks, group dynamics, system effects and social learning.

2.9.4 Social Learning Theory

Finally, the diffusion process can be explained by social learning theory. The basic argument of this theory is that, although people can learn through directly experiencing the consequences of

their own behaviour, most human behaviour is learned by observation through modeling; from observing others, one forms an idea of how new behaviours are performed, and on later occasions this coded information serve as a guide for action.

The theory argues that most human behaviour is learned by observation through the informative function of modeling which is usually determined by (i) Social psychological characteristics of the model, such as prestige, power, competence, expertise, and socio-economic status; (ii) the attributes of the observer, particularly their real or perceived similarity with the model; and (iii) the response and anticipated consequences associated with the behaviour.

Social learning theory also emphasizes the role of vicarious reinforcement and incentives. Vicarious reinforcement is indicated when observers increase behaviour which they have seen others reinforce while rewarded modeling is more effective than modeling alone in inducing behaviour. Furthermore, although observed positive consequences are also likely to foster adoption of behaviours, the theory predicts that direct incentives have greater motivation power than vicarious ones when it comes to maintaining behaviour over time. The theory also recognizes a number of factors that determine whether people will enact what they have learned. The major factors advocated by the theory are concerned with the attributes of the innovation, stimulus inducements and resources necessary for adoption of many innovations. Social learning theory generates the following points regarding the practical adoption of innovations:

(i) Innovations that are highly visible (operability), easy to match (complexity), and perceived to pose less harm or loss (risk) are likely to diffuse more rapidly.

(ii) Stimulus inducements associated with the innovation, such as anticipated satisfaction, observed or perceived benefits, functional value, and social approval act as motivation to adopt.

(iii) Direct incentives or tangible advantages have greater motivation than vicarious ones, particularly for sustaining the adopted innovation.

Therefore, innovations with long-run advantages but without immediate tangible advantages, are slow in diffusing.

Although social interaction models discussed above offers a fairly plausible explanation of the diffusion processes and elements, the major criticism is that they overemphasize the role of communication and particularly attaches special importance to persons through whom an innovation finds entry into a Social unit such as; models, and early adopters with the expectation that adoption of innovations will trickle down to the majority of the people. However, many studies have proved that the "trickle-down" process has not functioned to a desirable level and particularly for innovations that require substantial direct or indirect resources.

In summary, social learning theory postulates behaviour as being regulated by the interplay of self-generated and external sources of influence. The theory recognizes that there is a continuous reciprocal interaction among a person's behaviour, events going on inside of the person (thoughts, emotional reactions, and expectations) and the environmental consequences that feed back on behaviour, either maintaining or changing the probability of similar behaviour in the future (Zimbardo 1970).

Thus, in the social learning perspective, psychological functioning is a continuous reciprocal interaction between personal and environmental determinants. For example, people's expectations influence how they behave, and the outcome of their behaviour changes their expectations. In other words, the environment does not act upon individuals as postulated in the traditional social psychological formulation but rather is only a potentiality until actualized by appropriate actions. Similarly, according to Bandura (1977), personal determinants are only potentialities that do not operate as influences unless they are activated. Raush (1965) also showed that the antecedent acts of one person strongly influence how others respond, thus determining the course of interaction. In addition, role prescriptions-specifying how people are supposed to behave in carrying out their assigned roles-serve as structuring influences on the nature of reciprocal exchanges (Bandura, 1977). Furthermore, the circumstances or situations under which the interaction takes place should also be considered an important variable determining the pattern and, to some extent, the outcome of the interaction. Behaviour, including anticipated behaviour, partly determines which of the many potential environmental influences, in turn, partly determine which behavioural repertoires are developed and activated. In this two-way influence process, the environment can be influenced, as can the behaviour it regulates (Bandura, 1977).

In the case of innovative behaviour, social learning theory distinguishes two processes in the diffusion of innovations: the acquisition of innovative behaviours, and their adoption in practice (Bandura, 1977). The following points can be drawn from the social learning perspective with regard to the process of acquisition:

(1) Acquisition of innovative behaviour is achieved primarily through the informative function of modeling.

(2) Symbolic modeling, particularly from the mass media in the early stages of diffusion, functions as the principal conveyance of innovations. Early adopters, therefore, come from among those who have had greater exposure to mass media. Some of the variation in time of adoption partly results from differences in the time first exposure to innovations.

(3) In later stages of diffusion, innovation tend to spread through direct modeling along existing networks of interpersonal communication. Furthermore, individuals are likely to acquire innovative behaviour through their regular associates, either in preference or imposition, because such associates are important determinants of the behaviour that is repeatedly observed and hence most thoroughly learned.

(4) Innovators can sustain their innovative behaviour despite possible failure, high risks, and lack of social support through self-reinforcement mechanisms, while the majority of the adopters depend on vicarious reinforcement (seeing the advantages gained by early adopters) before embarking on innovative behaviour. Thus, modeled benefits tend to accelerate diffusion by weakening the restraints of the more cautions potential adopters.

(5) (a) Early adopters are likely to be effective models if they possess prestige, Competence, expertise, and high socio-economic status. (b) Adoption can be significantly influenced by real or assumed similarity between early adopters and potential adopters.

The apparent contradiction between (5a) and (5b) can be reconciled by the fact that individuals have a strong need to achieve cognitive consistency in their self-concept. Therefore, when a person perceives himself or herself as having some characteristics similar to a model, he or she will usually introject other attributes of the model in order to maintain cognitive or perceptual

consistency. In other words, although early adopters usually have more prestigious social psychological variables than later adopters, a single similarity in other characteristics, such as ethnic origin, neighbourhood, language or religion is sufficient to evoke a generalized similarity. This introjections phenomena also explains in part why diffusion takes place between model-observer, change agent-client, or opinion leader-follower despite their apparent dissimilarity.

From the social learning perspective, acquisition of innovations is necessary but not sufficient for adoption in practice. The theory also recognizes a number of factors that determine whether people will enact what they have learned. The major factors advocated by theory are concerned with the attributes of the innovation, stimulus inducements and resources necessary for adoption of many innovations. Social learning theory generates the following points regarding the practical adoption of innovations.

(1) Innovations that are highly visible (observability), easy to match (complexity), and perceived to pose less harm or loss (risk) are likely to diffuse more rapidly.

(2) Stimulus inducements associated with the innovation, such as anticipated satisfaction, observed or perceived benefits, functional value, and social approval, act as motivation to adopt. Positive and pervasive stimulus inducements increase the likelihood of the learned innovations being tried or adopted.

(3) Direct incentives or tangible advantages have greater motivation than vicarious ones, particularly for sustaining the adopted innovation. Therefore, innovations with long-run advantages but without immediate tangible advantages, such as many health related innovations, are slow in diffusing.

4. If people lack the money, skills, or needed accessory resources, they will not adopt even innovations favorable to themselves.

Today, many scholars increasingly blame the situation rather than the individual for not adopting the innovations. Consequently, this had led to socio-economic and structural approaches to diffusion of innovations. The major models and arguments supporting this perspective are socio-economic and structural models.

The Socio-economic and structural perspective is considered to be heuristically useful in understanding the diffusion process because it represents a view nearly opposite to most social psychological and social interaction models. This perspective basically argues that the manner and the rate with which an innovation is adopted cannot be interpreted independently from the socio-economic political and cultural systems where it is introduced. Many studies and models of human behaviour have demonstrated the importance of taking into account this structural perspective.

2.9.5 A Summary of Synthesis of Diffusion models

In the analysis of the diffusion literature, the models were grouped into several categories to represent different perspectives, although there was some degree of overlap among some perspectives. The first model, which is; termed "marketing models of diffusion," mainly explained the diffusion process in terms of (1) cost and cost-effectiveness of the innovation, (2) the innovations level of technological development, (3) the role of supporting institutions, (4) the amount of useful life left in the technology being replaced, and (5) the customer's level of information (knowledge) about the innovation. In addition, the market diffusion models offer a system of assessing and predicting the impact of intervention such as government incentives on the diffusion process. However, the market diffusion models are limited in explaining the diffusion process in that the excellence of an innovation in terms of; technological performance and cost-effectiveness does not always guarantee successful diffusion. More often, there are many other non-economic and non-technical factors that influence the acceptance of a new technology. Furthermore, marketing models do not offer theoretical knowledge of why and which individuals do or do not invest in a new technology.

The second group of models, termed "individual needs approach", stipulates that the individual's needs are the most important motivation or mechanism leading to specific behaviour. The approach also argues that the individual's need, whether economic, social, or psychological, leads to a search and retrieval of ideas and information that can be used in decision-making and in selecting ideas or innovations that can satisfy the need or reduce the cognitive dissonance. The main weakness of this perspective is that not all individual needs lead to specific behaviour nor are needs always satisfied. Therefore, there must either be factors that intervene in the process or

for deciding which needs lead to specific behaviour. Furthermore, situations that might lead to a state of dissonance or create particular needs are frequently avoided. The individual seeks only information expected to support or confirm a decision already made through selective exposure, selective perception, or even forgetting dissonant information. Therefore, at best, out of the potential array of needs, only a few may lead to specific behaviour and much less to the adoption of innovations.

The third group of models, the "social-interaction approach," is probably the most comprehensive since it touches on a number of disciplines, particularly sociology, social psychology, and communication.

The classical diffusion theory deals with how an innovation spreads, over time, among units (usually individuals in a social system). According to this theory, interpersonal networks are the main communication channels through which an innovation diffuses from an individual who has adopted the new idea to other individual in a social system. The theory attaches special importance to persons through whom an innovation finds entry into a social system, particularly the "innovators," early adopters," and "opinion leaders," because of their influence on others. In addition, the theory predicts that the rate of adoption of innovations is determined by (1) the perceived attributes of the innovation, such as relative advantage, compatibility, complexity, triability, and absorbability; (2) the type of innovation –decision, whether optional, collective, or from authority; (3) the nature of the social system (e.g. modern or traditional norms, and degree of communication integration); and (4) the extent of change agents' promotional efforts. Although the theory does mention that social-structural features of the system has impact on the diffusion process, most empirical studies using this approach, at least until the mid-1970's, focused primarily on the individual as the unit of analysis and also took a pro-innovation" position. The individual was viewed as a passive consumer rather than active in decision-making. Consequently, the classical diffusion theory has been criticized for blaming only the individual rather than the system when innovations have failed to diffuse and for being insensitive to contextual and social-structural factors in the society. Furthermore, the diffusion theory has been criticized for overemphasizing the role of communication on the diffusion process. That is, whereas communication is necessary in the diffusion process, acting alone,

communication cannot lead to meaningful change, particularly adoption of innovations. In summary, critics of the theory view communication as an intervening variable rather than a causal (independent) variable.

On the other hand, the basic perspective of social learning theory is that, although people can learn through directly experiencing the consequence of their own behaviour, most human behaviour is learned absorbability through modeling; from observing others, one forms an idea of how new behaviour is performed, and on later occasions this coded information serves as a guide for action. Thus, modeling influences learning principally through its informative function which is acquired mainly through verbal exchange of information and also through non-verbal communication. Second, social learning theory as compared to other psychological learning theories recognizes factors external to the individual as well as internal factors such as thoughts, emotional reactions, and expectations as important to behavioural change.

The social learning theory also distinguishes two processes or stages in the diffusion of innovations: (1) the acquisition of innovative behaviour, and (2), the practical adoption of the innovation. Central to the acquisition process is the informative function of modeling, through mass media in the early stages of diffusion, and through direct modeling along interpersonal communication networks in the later stages of diffusion. Therefore, as in the classical diffusion theory, early adopters in social learning theory are important because they act as models in the diffusion process. Finally, from a social learning perspective, acquisition of innovations is a necessary but not sufficient factor for adoption of innovations in precise. In addition, the social learning theory recognizes that (1) the attributes of the innovation (such as the risk involved, complexity, and absorbability), (2) the stimulus inducements associated with the innovation (such as anticipated satisfaction, observed or perceived benefits, functional values, and social approval), and (3) resources (such as money, skill, and other accessories) are important for the practical adoption of innovations.

Although the social learning theory does distinguish the role of information (acquisition of innovative behaviour) from that of motivation (stimulus inducements) and resources in the diffusion process, the theory does not deal adequately with the influence of socio-economic and

structural factors, particularly at the macro-level such as social, economic, and political systems and institutions.

Among the theories of social-interaction, the models of group dynamics represent a step farther from viewing the individual in more or less isolation to focusing on the individual in a social setting or group. According to group theories, rather than being an isolated, passive processor or information, the individual is seen as having an intimate dependence on others for knowledge attitude and decision. Second, the group dynamics approach is in many ways an extension of the individual needs approach in that the major motivation for behavioural change is shifted from being the individual's needs to being group-based needs, such as the need for social association, the need to compare oneself to others, the need to evaluate one's own abilities and attitudes with respect to others, and the need to reduce discrepancies between one's own position and that of the group. According to group theories, groups exert considerable influence on an individual's values, beliefs, attitudes, and behaviour because they satisfy needs, help the individual attain important goals, and can reward a member for compliance or punish for deviance. Central to group influence is also the concept of group cohesiveness or integration and intra-communication. The models predict that groups that have a high degree of cohesion or integration and intra-communication tend to have more influence on the individual.

The following conclusions can be drawn when we compare and construct the models. Information is obviously a common factor in all the models considered in this study, although the importance and the role assigned to information may vary from one model to another. For example, the focus in marketing models is on the role of consumer information about the product (i.e. the innovation). The individual needs approach argues that needs lead to search and retrieval of ideas and information that can be used in decision-making and in the selection of the idea(s) or innovation(s) that can satisfy the original need or reduce the cognitive dissonance. In the social-interaction models, individuals change their overt behaviour as a result of communicating with another individual. In the structuralist approach, information is viewed as one of the resources that has to be acquired if change is to occur, particularly among the less advantaged sectors.

2.9.6 Theoretical Framework of the study

Introduction

In an attempt to understand the adoption of solar technology, it is necessary to come up with a theoretical framework that is based not only on models but also concepts from various disciplines in social science.

A major observation of most theories and models that explain the diffusion of innovations is that they tend to be confined in scope to a particular discipline. For example, the primary factor accounting for the diffusion of innovation in social psychology largely deals with individual personality variables; in sociology, social systems and structures, in marketing and economics, the cost-effectiveness of the innovation. Although the multi-disciplinary and interdisciplinary background of communication might lead one to expect an integration of various diffusion traditions, one still finds over emphasis on the role of communication in the diffusion process. Therefore, in most cases, the models handle the diffusion process in a very disintegrated manner.

The main argument here is that it is unlikely that a single approach will adequately explain the adoption process. Certainly, analysis of the models strongly indicate that a plausible theoretical framework will require a synthesis of variables from many models. In fact, a close examination of the models and concepts show that, in general, most are complementary rather than contradictory, each model explaining or elucidating a particular aspect of the diffusion process.

A review of diffusion literature indicates several distinct models or orientations that have implication on the diffusion or adoption of solar technology, although there is some similarity and overlap amongst them. These models are **Marketing,. Social-psychological, Social interaction and Social structural**.

A comparative analysis of the above models seems necessary. The first section briefly describes each category of the models, particularly its basic assumption, elements and how they relate to the diffusion of practice, idea or technology. The second section synthesize the strong point from each model. Any similarity or overlap is taken as confirmation of a common proposition; differences will be examined to determine whether they represent competing or complementary

views. This synthesis is used to propose a diffusion model for describing the acceptance of solar technology in the area under study.

It is important to note that this analysis is not exhaustive. First, other models exist which either explicitly or implicitly focus on the diffusion process. Therefore, the study concentrates on three major marketing models i.e. the market penetration model, the substitution model and the rate of imitation model because most of them are complementary to each model explaining a difference aspect of the adoption process.

CHAPTER THREE

Methodology

3.1 Introduction

This chapter details the procedure that the researcher followed in conducting the study in order to achieve the earlier stated objectives. The chapter gives details of the research design, the research population that were studied, research site, selection and description, sample design and sampling procedure, data analyzing and limitation of the study

3.2 Research site selection and description

The target population are the community of Katulani sub-location in Kitui district. It comprises of 1000 homesteads according to Kitui district statistical report (2005). A homestead in this study refers to a family unit. Therefore, it is possible to find several homesteads in one compound.

3.3 Sample design and sampling procedure

The sample population was drawn from the population of the homesteads of the people in the sub-location. Since the area of study is expansive and that the number of households is large, it was deemed necessary to use a purposive sample of only 100 households as respondents. In a survey, data is a collected from a sample. A sample is a subgroup of individuals selected from population (Baxtes and Babbie,2004) Kothari (2004) refers to sampling as the process of selecting part of the elements in the population so that conclusions are drawn about the entire population.

Once analysis of the data collected from the sample is done, The findings can then be generalized to the large population (Mugenda and Mugenda 2003). Baxter and Babbie (2004) advice that a sample must adequately represent the characteristic of the entire population; that is the selected sample must be almost as accurate as studying the entire population. Palier (1994) explains that samples studies that are deterministic and descriptive in nature are deemed adequate within 10% of the target population, while Mugenda and Mugenda (2004) recommends a sample size of 30%.

The researcher targeted a total survey of 100 households and considering the entire population of 1000 households, this represented 10% of the population which is within 10-30% bracket. Since the survey was purposive, the researcher had to move from one household to another. Provided that in that household there was a permanent house, on which solar panel can be installed.

Katulani location has a total number of 1000 households. This represented the entire population of the study. Since Katulani location is too expansive, coupled with lack of funding for the study and limited time under which the study was to be conducted, the researcher purposively selected a sample of 100 households. This represented 10% of the entire population. The purposive sampling was based on first on those who have already adopted the solar technology. Secondly, households that have structure where solar technology can be installed but have not adopted the technology and lastly the willingness of the respondents to spare time and respond to interview questions.

3.4 Data Sources and Data Collection Methods

The researcher utilized both primary and secondary methods of data collection.

3.4.1 Primary Data

Observation: In order to obtain primary data, the research undertook field observations noting the extent to which solar technology is in use in Katulani sub-location. This was possible because the solar panels are openly displayed whenever they are used hence ability to note households that utilize solar energy. Due to the study being qualitative in nature, data and information was also collected using observation as a methodology.

Further, the social economic status can be observed from the lifestyles of the people in the form of homes built. Utilities like water and fuel sources, food availability and the health facilities which have a great bearing on the social economic status of any community. Primary data was also collected using a questionnaire that was designed and administered by the researcher to the selected sample. The questionnaire contained questions which sought information on the use of solar energy, information sources on solar technology and other complimentary sources of energy. See appendix A.

Face to Face Interview: This study utilized a face to face interview as a method of data collectio using questionnaire. An interview guide was designed for data collection purposes. Interview guidelines are considered most appropriate in studies in education (Borg 1983), interviews permit a more thorough understanding of the respondents' opinions and provide a desirable combination of objectivity and depth. Semi-structured interview schedules often permit the gathering of valuable data that could not be successfully obtained by any other research approaches. It should be noted however, that while the method has its advantages it has also some limitations as outlined below.

Advantage of Using Personal Interviews

While personal interviews as a research method are considered to be the most costly form of data collection in general (Witley 1996) they however, offer important advantages. These include:

- The ability of the interviewer to notice and correct the respondents' misunderstandings in the process of interviewing;
- Probing those repossesses that are inadequate and vague;
- Answering questions and clarifying concerns of the interviewees;
- Unlike the questionnaire, an interview enables the interviewer to control the order in which the respondent receives the questions. A response to an interview item influences the interviewer to reset a question that was asked; and
- Attaining the highest response rate when compared with other survey techniques.

3.4.2 Secondary Data

The research consulted documentary sources on solar in Kenya in general. This included gathering information from the Internet and newspapers and statistical annual reports on energy, library research on renewable energy in Kenya. Those sources yielded valuable information on solar energy usage and adoption in Kenya.

Content Analysis: This study utilized content analysis. Content analysis as defined by Baxtes and Babbie (2004) is a technique for the systematic replicable and quantitative description for the manifest or latent features of the communication texts (P. 240) therefore providing reliable data. This reearch method, according to Wimmerr and Dominick (1987), provides researchers with an

efficient way to investigate the content of the media... (P. 165) Wimmer and Dominick further explained that content analysis aims at ststematic evaluation given that only one set of guidelines for the evaluation is used throughout the study. (P. 166)

Additionally, content analysis reinforces objectivity as researchers provide operational definition and rules for classification of variable, which allow replication of studies. Content analysis is also quantitative enabling researchers to summarize and report results with precision. The researcher undertook content analysis of three newspapers that is, Nation newspaper, the Standard and the People to assess the level of awareness created by the media through advertisements. It was noted that that there are irregular media advertisement on solar technology. It was also noted that the advertisement are usually placed in places that are not popular with the readers.

Additionally, these advertisements are placed together on the same page with other competing products or placed together with for example advertiser's announcements. This is almost impossible for the reader's to notice the advertisement. Again, the newspapers advertisement have little appeal to the people in the rural areas because the newspaper are not readily available and the literacy level is also low in the rural areas where the study was based. Therefore the low adoption rate of solar technology can be attributed to low levels of awareness among the members of the rural community in Katulani sub-location.

3.5 Data Analysis , Interpretation and Presentation

The data collected, was analyzed through tabulations, frequencies drawn, percentages of responses generalized, averages calculated, other statistical method like pie chart, bar graphs and histogram have been used widely in the presentation of the data.

Due to the study being qualitative in nature, interpretation and presentation were made on the basis of the field observations and responses by interviewees as will be seen in chapter 4.

3.6 Problem, Constraints and Limitations of the Study

- Most of the respondents were unwilling to participate in the study as they treated the researcher suspiciously.

- The research was a part time study hence combing study activity and job engagement proved to be a real constraint.

- The sample and generalization made on it are only limited to one sub-location hence making generalizations on this for the entire country based on one sub-location may not representative.

- Lack of computer with appropriate software to analyze the data – hence the research took a long time to process the work.

- The research was expensive since it was self-sponsored.

CHAPTER FOUR

Data Presentation and Discussion of the findings

4.1 Introduction

In presenting the results on the adoption of solar energy technology in Katulani sub-location, tables, illustrations, percentages, histograms and even diagrams have been used.

Already developed are guiding questions that have been used to acquire specific information leading to adoption of the technology which also hinges on the qualitative aspects of the results.

4.2 Social Demographic of the Study Sample

Most of the people in Katulani are not in the formal employment. Those who are employed are in the teaching profession. The majority are either in the informal sector (business people) or are not employed at all. Based on the energy requirement in Katulani sub-location (weather conditions, fuel availability, household size, availability of sunny space and fuel prices) Katulani sub-location was selected to study the adoption of solar technology.

Katulani sub-location is a small rural village located 20km from the nearest Kitui town. There is a fuel mix with wood and paraffin used in almost in unequal proportions. The sub-location has no access to electricity. The population is composed of school going children, youth who have completed their education, working people and the old people. The economic activities in the area include crop farming and livestock keeping on small scale.

4.3 Response rate

The researcher selected a sample of 100 respondents. Questions were dropped to the respondents for self answering in advance. This was necessary since during piloting it was noted that when making appointments for carrying out interviews some respondents preferred to be provided with interview guide before hand. Out of the 100 interviewed guides, 80 interview guides were returned satisfactorily answered. This represented 80% of the sample selected.

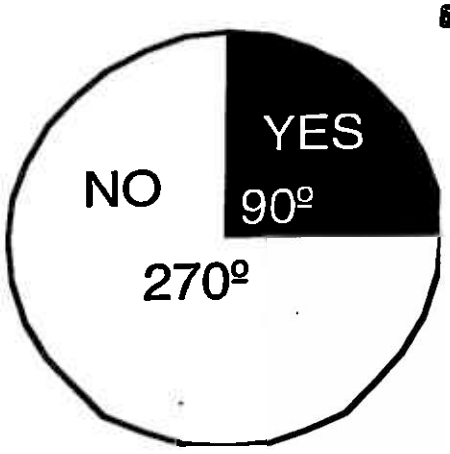
4.4 Uses of the Solar Energy

The researchers sought to establish whether solar energy was in use in the sub-location. Apart from observation on those who have installed the solar panels in their houses; the respondents were asked whether they make use of solar energy in their homes. The responses are shown in the table below.

Table 4.4: Uses of Solar Energy

	No. of respondents	Percentage
Yes	20	25%
No	60	75%

From the table it can be seen that 25% of the respondents make use of solar energy while 75% do not make use of solar energy in their homes. This clearly shows that the use of solar energy is not wide spread. Thus there are few people who are using solar energy in the sub-location despite the fact that, solar radiation is abundant in our Tropical African. The above information can also be depicted in a ven diagram as shown below.



Use of solar energy illustrated using Ven diagram.

One of the assumption of the Research Development and diffusion approach holds that more or less rational consumer will accept and adopt the innovations if it is offered to one in the right place at the right time and in the right form.

According to March and Simon (1958) and Mansfield (1971), innovation decision are less a product of rational and planned action and more of a product of taking action based on hunches, muddling through and ex-post-factor rationalization. Rongers and others (1980) in a study investigating the process in which technological innovations is formed and developed in a technology industry (solar and micro-process industries) suggested that inversion and development of innovations is dynamic process and is heavily dependent on the flow of information about the performance of the innovation, materials and components of innovation, competitor's products, nature of the existing patents related to the innovation, government policies affecting the innovation, market problems and the behaviour of the members in the innovating firm. Therefore the system of information exchange about innovations is a crucial component affecting the success of the innovation because the process of innovations largely involves personal and social uncertainties.

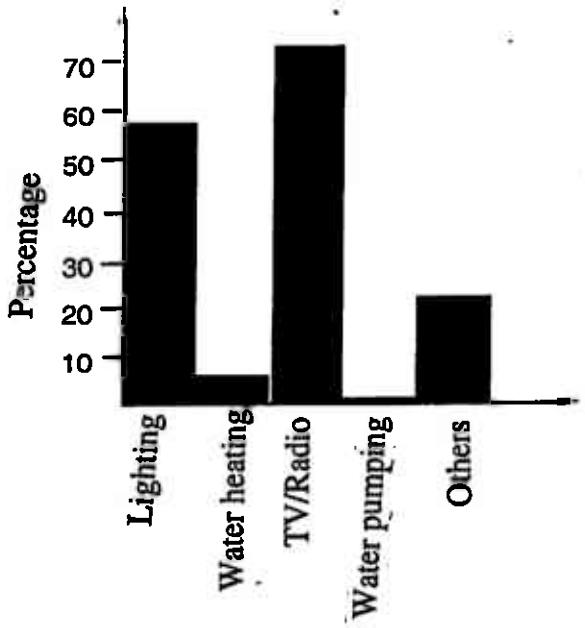
4.5 Information on the application of Solar Energy

The respondents were asked a question regarding the uses to which they put the Solar Energy to, those who have adopted Solar noted that they use it for various purposes as tabulated below.

Table 4.5: Distribution of respondents on the uses of Solar Energy

Solar Energy Uses	No. of Respondents	Percentage
Lighting	47	58.75%
Water heating	5	6.25
Powering TV/Radio	58	72.5
Water pumping	1	1.25
Any other	19	23.75

The above information is also depicted in the Histogram below



From the information obtained from the respondents, it shows that solar energy is used for two main purposes, that is lighting the houses 58.75% and TV/Radio powering, 72.5%. Majority of the people don't use solar energy for other purposes like water heating 6.25% and water pumping 1.25%. Other uses to which solar energy is put into constitutes 23.75%. The other uses as stated by the respondent included, phone charging, used to power calculators, ironing clothes and air cutting. This information is clearly depicted in the histogram above.

4.6 Information on the adoption of solar energy

New technology, innovation or idea diffuse in society through various informational sources. This too applies to solar energy technology. The respondent noted that there are various sources from where they obtained the initial information on the use and efficiency of solar energy. The majority 43,75% sited relative and friends as the conveyers of this information. The other sources are shown in the table 4.5 below

Table 4.5 showing distribution of respondents on information sources

	No of respondents	Percentage
Neighbour	24.	30
Solar energy persons	20	25
Newspapers Advertisements	31	38.75
Radio Advert	19	23.75
TV Ad	16	20
Relatives and friends	35	43.75
Personal enquires	12	15
Don't know	19	23.75

Table 4.5 the distribution of respondents on information sources about solar energy is depicted in the table above. Relatives and friends (43.75%), Newspapers advertisements (38.75) and Neighbours 30% are very instrumental in creating awareness. As noted by Rogers and schoemaker (1973), once the individual becomes aware of a felt need or problem, seeks information about some means such as innovation to meet his/her needs. This information is usually sought from relatives or neighbours. These constitutes what is referred to as word of "mouth advertisements". These are very effective because informal communication network increases the explanatory power of a diffusion. The Informal network also help to answer some of the crucial diffusion questions such as how information about innovation became available, where and to whom this information is presented and most important, the reasons for how, where and to whom. Rogers and Kincaid 1981: Rogers 1975 and Granovetter 1973 suggested that the apparent randomness in the adoptation of innovations could be reduced once the interpersonal communication networks in a community are understood.

Closely related to interpersonal communication networks in explaining the diffusion process is the group dynamic approach. This perspective views individual as a social being with intimate dependence on others for knowledge and decisions on his/her attitude and action. The group one belongs to, identifies with or even avoids joining are important in shaping beliefs, attitude and behaviour.

A myriad of factors may cause some individual to have high initial resistance to innovations while others have relatively low resistance. Rogers and Schoemake (1971) noted that when the level of information about an innovation is very low, adoption of innovation is unlikely for any given individual.

However, as the level of information increases, past certain threshold, adoption is more likely to occur as self generated pressures towards adoption increases. In other words, adoption is increased by each individual input of the knowledge and influence to the systems communication environment.

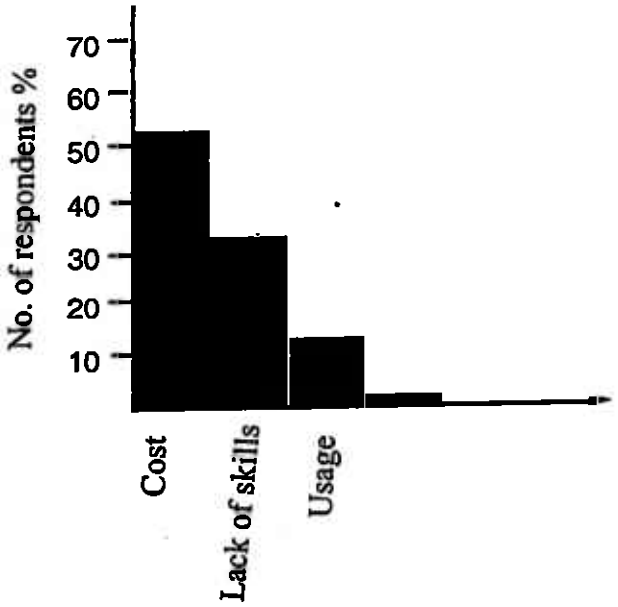
4.7 Reasons for non-use/adopting solar energy

The findings of the reasons why people do not use solar energy are shown in table 4.6

Table 4.6 showing the reasons why people do not use solar energy

Reasons of non-use	No. of respondent	Percentage %
Expensive (costly)	41	51.25.
Do not know how to use it	27	33.75
Use it	10	12.5
Not available	2	2.5

The researchers noted from the respondents a good number 51.75 percent do not use solar energy. Those people cited cost as their limiting factor. They said the cost of installation, the actual purchase of panels and other accessories is beyond their means. The other reason for non use of solar energy are: none availability of the panels and accessories 2.5%: 12.5% of the respondents said that they use the solar energy while 33.75% of respondent do not use it because they do not have the skills to use it. Consequently, from the social learning perspective, if people lack money, skills or needed accessory resources, they will not adopt even innovations favorable to themselves. Since 33.75 percent of the respondent said they do not know how to use the technology, it follows therefore that the complexity of solar energy technology is inversely related to its adoption. Thus complexity of the technology is a factor inhibiting its adoption. The finding for the reason why people don't use solar energy are shown in the Histogram below.

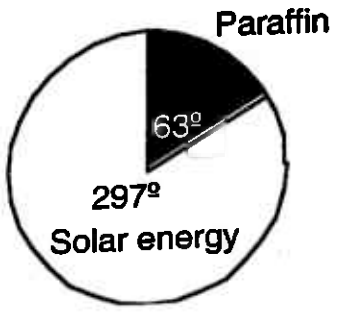


4.8 Convenience of solar energy in relation to other sources of energy

The researcher wanted to know whether the respondents have noted benefit of solar energy compared to the other competing sources of energy. The findings in the Table 4.7 illustrate views of the respondents.

Table 4.7: Convenience of Solar Energy

Sources of energy	No. of respondents	Percentage
Paraffin	14	17.5%
Gas	0	0
Petrol/diesel	0	0
Solar energy	66	82.5%



A majority 82.5% noted that solar energy is convenient relative to the other sources of energy. The social learning theory generates the following points regarding the practical adoption of innovation.

1. Innovation that are highly visible (absorbability) easy to match (complexity) and perceived to pose less loss are likely to diffuse more rapidly.
2. Stimulus inducement associated with the innovation, such as anticipated satisfaction, observed or perceived benefits, functional value and social approval, acts as motivation to adopt Bandura (1977). Therefore from the findings above, the respondent seem to now that solar energy has benefit relative to the other sources of energy yet, the adoption is slow. This clearly depicts that there are other intervening factor that thwart rapid adoption of this technology.

4.9 Distribution centres for the solar energy technology

As a new product, the researcher wanted to know whether there are adequate distribution centres for the technology. A majority noted that there are selling agents from ART (African Retail Traders) who sell the solar panels to the prospective customers. However they do not provide the after sale services. The other agents sited by respondents include:

- Electrical dealer shops
- Selling agents from Nairobi

Table 4.8 shows that there are few distribution centres and that there are quite a number of respondents who do not know where to obtain the necessary equipment from.

Table 4.8 showing the distribution centers for solar technology

Source of equipment	No. of respondents	Percentage %
Electrical and ART shops in Kitui Town	38	47.5
Agents from Nairobi	20	25
Don't know where to get the Equipment	22	27.5

A majority of the respondents 47.5% said that they obtained the equipment from Kitui Town. Either from ART shops or electrical shops. Kitui Town is some 20 km from Katuleni Sub-Location. This shows that distance from the Sub-Location and the main town could be an

adequate reason for people not to adopt to the technology. Another 25% of the respondents claimed to have obtained the equipment from Nairobi sales agents which is quite a considerable distance from the sub-location. Those who have not adopted the technology said that they do not even know where to obtain the equipment and these formed 27.5% of the people interviewed. Inadequate distribution centre is a factor contributing to slow adoptation of solar energy technology.

4.10 Relevance of information on the new technology

The researcher wanted to establish the reliability of the information given from various sources. The findings were that information received on solar energy technology from various sources is not clear or explicit to the potential users of the technology. The responses from the respondents are shown in Table 4.10 below

Table 4.10 showing the clarity and explicity of the information on solar technology

Clarity and Explicit of the information given about the technology	No. respondents	%
Yes	20	25
No	49	61.25
Not decided	11	13.75

The findings in Table 4.9 shows that 25% of the respondents said that the information given on the solar technology is clear and explicit for potential user of the technology while 61.25% said that the information given is not clear and explicit for potential use of the technology. Thus the majority were of view that the information given is not a sufficient motivation to adopt the technology. The undecided respondents represented 13.75%

4.11 Use of solar energy in schools as change agents

The researchers wanted to established the effect growth centres have on diffusion of new technology. It was observed that villages that were near the Katulani market centre and boarding school that were using solar energy have a relatively high number of people who have adopted this technology. As the distance increased from the growth centers the level of awareness and the

relevance of the new technology reduced. The findings of the people living around the growth center as shown in Table 4.11 below.

Table 4.11: Solar use around the growth centers.

Use of solar in school	No of respondents	Percentage
Yes	50	62.5
No	30	37.5

From those who had noted that there were boarding schools that were using solar energy technology 62.5% had seen and appreciated the importance the technology and hence adopted it. As the distance increased from the growth centres the level of awareness and relevance of the technology to people decreased since only 37.5% had adopted the new technology.

4.12 Technological awareness campaign

The use of demonstration campaigns for adoption of new technology is very important in awareness creation and in convincing prospective adaptors of a new technology on its use and efficacy. The finding on the demonstrations are shown in Table 4.12 below.

Table 4.12 showing the level of solar technological awareness campaign

	No. of respondents	Percentage
Yes	25	31.25
No	55	68.75

The findings in the Table 4.12 show that 31.25% had seen solar demonstration campaigns while 68.75% had not seen solar energy being demonstrated. This according to classical diffusion of innovation by Rogers and Schoremakes (1971), the rate of adoption of innovation is determined by absorbability that is the degree to which the results of an innovation are visible to others. Therefore in a situation where there are no demonstration campaign the rate of adoption is likely to be slow because the results of an innovation are not visible to the adaptors.

4.13 The solar energy solution to energy problems

The researcher wanted to establish the relative importance of solar energy and as a consequence the readiness with which people are willing to adopt it, The sub-location lack firewood, no electricity, paraffin is expensive to many of local people and there is abundant sunshine which can be harnessed easily through solar radiation.

Table 4.13 showing that solar energy is a solution to energy problems

Solar solution	No, of respondents	Percentage
Yes	78	93.75
No	2	2.5
Total	80	100

The finding in Table 4.13 shows that an overwhelming 93.25% of respondent noted that solar energy can solve their energy problem while only 2.5% thought that solar energy cannot solve their energy problem. This is a very small number that can be ignored.

Table 4.14 showing the affordability of solar technology

Solar affordable by average residents	No. of respondents	Percentage
Yes	25	31.25
No	55	68.75

The findings in table 4.14 shows that solar installation is generally unaffordable by the majority of the people around Katulani sub-location. The total number of respondent who said that solar is generally unaffordable 55 (68.75%) while only 25 (31.25%) said that solar is affordable by the average residents in Katulani sub-location.

The table below shows a quotation from one of solar selling companies. This quotation, is for a panel which can light 6 bulbs, A radio and TV/Video for five and a half hours a day.

2 panels 110w @ 47000	= Ksh. 94000
2 Frame guards	= Ksh. 5000
2 150 Alt Batteries @ 11700	= Ksh. 23400
1 Jokar 275 w	= Ksh. 26000
6 Ac lights @ 500	= Ksh. 3000
2 rolls 2.5. mm T/FC	= Ksh. 10000
Installations materials	= Ksh. 4500
Labour	= Ksh. 11000
Total	**= Ksh. 176900**

The above quotation shows that solar installation is generally not affordable by residents of Katulani sub-location given their social economic status. Asked to give their comment about solar energy utilization. Majority 60 (75%) were of the view that solar energy installation is generally unaffordable while 20 (25%) had no comment. The fact that solar energy installation is expensive makes people consider alterative sources of energy such as generators which are cheap to buy and more reliable since they don't rely on the sunshine. Thus there is competition from alternative sources of energy.

Table 4.15 below shows the responses the respondent gave when asked to comment about solar energy utilization.

Comment	No. respondents	Percentage
Not affordable	60	75
No comment	20	25

The above findings explains why there is slow rate of adoption in the solar energy technology. Manfied (1977), model predicts that the number of individuals adopting innovation in a given period is a function of several factors such as: The size of the investment need to acquire and install the innovation, other things being equal an innovation which requires relatively small

investment will diffuse faster then the one requiring large investment because it represents less financial risk. Again, the number of years of useful life left in the product or technology being replaced. Most people are likely to continue using the technology being replaced, if it is in good conditions particularly when dealing with costly investment innovations. Thus, the state of the technology to be replaced (or substitute) may determine when one is going to adopt the innovation regardless of the individuals general degree or innovativeness of the cost effectiveness of the new technology.

4.16 Availability of qualified personnel

The researcher wanted to find out if there competent people who can be employed not only to install the solar panels but also give expert advise.

The findings in table 4.16 show that there are no competent people to offer the necessary services in Katulani sub-location.

Table 4.16 showing the availability of qualified personnel

Availability of competent	No. of respondent	Percentage
Yes	15	18.75
No	65	81.25

The findings in the table 4.16 shows that 81.25 percent respondent were of the view that there is or competent people to install solar energy while 18.75 percent were of the view that there are competent people.

4.17 The factors inhibiting widespread adoption of solar energy technology

Though widely seen as a solution to the energy problems, the adoption of solar energy technology is not wide spread, in Katulani Sub-Location, the few people who have adopted the technology seem to have done so because of the perceived profitability a adopting the technology. Therefore, the following are the factors which have contributed to slow rate of adopting the solar energy technology.

(i) *Small population of the people who have adopted the technology.* The proportion of individual that have previously adopted the technology is a factors contributing to slow rate of adoption. This is because the number of previous adopters increases the volume of

information about and the experience with the innovation, thereby reducing risk in adopting it, a process usually referred to as a word of mouth advertising. The finding depict that only 25 percent of the respondent have adopted the technology while 75 percent have not. This is in line with manfields (1979) rate of imitation model as it was noted in the literature review.

This again is line with the social learning theory which stipulate that, though people can learn directly through experiencing the consequences of their own behaviour, most human behaviour is learned by observation through modeling, from observing others, one forms an idea of how new behaviour are performed and on later occasions this coded information serves as a guide for action.

(ii) *The existing competition*: solar energy technology seem to face stiff competition from other forms of energy such as electricity, wood fuel, paraffin and generators. The number of years of useful life of the technology to be replaced by solar energy seem to long. Many people would like to continues using those other forms of energy so long as they are available and in good condition. Thus the state the technology to be replaced may determine when one is going to adopt the innovation regardless of the individual degree of awareness of the new technology.

(iii) *The size of the investment needed to acquire and install the innovation*: Other things being equal on innovations which require relatively small investment will diffuse faster then one requiring a large investment because it represents less financial risk. The majority 51.75 percent of the respondent sited cost as their limiting factor regarding the acceptance of solar energy technology. The cost of installation, the actual purchase of panels and other accessories is way above the means of the majority of the people in the sub-location. In the process of acquisition of innovative behaviour, (Bandura 1977) argues that, if people lack the money or needed accessories, they will not adopt innovation favourable to themselves.

(iv) *The level of solar technological development.* Low level of solar technological development is seen as a factor contributing to slow rate of adoption.

Mr John Keane is a British volunteer who has seen promoting solar panels in Kenya for nearly three years. He is involved with projects in Kibera and Nanyuki to get youth to make and sell panels using DIY method from British non-profit group Bio Design. Mr Keane acknowledges that current cheap solar technology is limited to radios and small appliances, but those can be vital tools. "Everybody needs a radio and there are lot that aren't turned on in rural Africa because people can't afford to buy batteries all the time he says. Quoted from Daily Nation Tuesday December 2005 page 14.

(v) *Lack of supporting institutions such marketing and credit organization including government.* Supporting institution such as market, credit and government play a very vital role in promoting acceptance of a product, technology or idea. It was found that in Katulani Sub-Location the role of those institutions is minimal since 47.5% said that the equipment can be obtained some 20 kilometre away from Katulani Sub-Location where the government and credit institution are located.

(vi) *The potential customers' level of knowledge or information about the innovation.* Innovation will diffuse faster where people have knowledge and accurate information about the innovation. In the case of solar energy technology, people in Katulani Sub-Location do not seem to have adequate information or knowledge about solar energy technology. Since only 25% of the people interviewed said that the information they have so far received on solar energy is clear and explicit while the majority 61.25% were of the view that the information given from various sources is not clear and explicit. Again very few people 31.25% have seen solar technology being demonstrated while the majority 68.75 have not seen solar energy technology being demonstrated in the sub-location. Therefore this like of information compiled with low levels of awareness explain why the rate of adoption is low.

(vii) *The supply problem in the technology delivery system.* There is a serious problem on the supply side of delivery system concerning the solar energy technology in the area. The suppliers are located too far, some 25 kilometers. In some instance those who adopted the technology obtained the equipment and the information from agents from Nairobi. This is to suggest that the excellence of an innovation in terms of cost effectiveness in an ideal situation does not guarantee its successful diffusion. More often there are other factors influencing the acceptance of the new technology.

(viii) *Lack of competent persons to offer advise and the practical installation of solar panels.*

Katulani Sub-Location does not have enough qualified people to install solar panels and offer the necessary advise to people wishing to adopt the technology. The finding showed that 81.25% said that there are no competent people to install the technology. This coupled with the complexity of the new technology explains why people are slow in adopting that technology in Katulani Sub-Location.

(ix) Lack of after sales services

Any new technology require through information, after sales services, guarantees and warranties. This does seem to be the case with the solar technology. Those who have installed the panels do not get after sales services which are very vital ingredient for the success of solar energy adoption.

CHAPTER FIVE

Summary, conclusion and recommendations

5.1 Summary

In this chapter conclusion has been made to answer the major research question on how do people pay attention to a given innovation, why are the people unwilling to adopt solar technology? How do people get information about a new product, who are the change agents and finding what makes people accept or reject a given innovation.

Lessons drawn from the findings of this study and those from literature review on similar studies will be presented and compared. The method of data collection that have given rise to the findings will briefly be presented. Conclusion to the research problem and answers to the accompanying research question will be provided. Apart from the limitation of the study outlined in chapter one. Other limitations that emerged in the process of carrying out the study have also been stated. Recommendations for further research have been made.

5.2 Conclusion

As state in chapter one, in carrying out this study, the research was guided by research objectives with accompanying questions. The findings of the study were specifically collected with the purpose of responding to the following study objectives.

1. To identify and examine the level of solar energy use in the Katulani Sub-Location.
2. To examine and investigate the factor influencing the adoption of solar energy technology in Katulani Sub-Location.
3. To recommend measures that can be used to gain widespread adoption of solar technology in Katulani sub-location.

The researcher set out to study the factors influencing the adoption of solar. To achieve this objective, the researcher employed field observation and interview methods to collect in-depth information about the factors inhibiting widespread adoption of solar technology.

The study finding revealed that low levels of income inhibit widespread adoption of solar energy technology. Conclusively from the social learning theory point of view people will not

adopt an innovation if they have no money, skills or needed accessory resources. This is true even in a situation where the innovations are favourable to the people.

5.2. 1 Lack of skills and experts

Furthermore, the potential users of the technology lack the needed skill to make use of the technology and this coupled with lack of experts to install and provide advisory services contributes to the slow rate of the adoption of solar technology.

5.2.2 Level of awareness

Another factor that contributes to slow rate of adoption of this technology is low level of awareness. The fact that there are media advertisements does not really mean successful adoption. This is mainly because the awareness is made in newspapers and in radio programmes which are not available to the rural community. Even where radios are available, they are always not turned on because people cannot afford to by batteries every time.

5.2.3 Small number of early adopters

The proportion of the people who have adopted the technology is very small. These are people who can be seen as change agents, the people Rogers call the early adopters. These people are supposed to increase the volume of information about the innovation thus reducing doubt, performance bugs and the initial resistance about the technology. Thus the low levels of potential customers knowledge or information about innovation is a factor contributing to the slow rate of adoption.

5.2.4 Level of technological development

The level of solar technological development seem to be in its introduction stage of the life cycle of the product development. This stage of any product is associated with performance bugs, diseconomies of small scale, low marginal cost comparison, few contracts arrangement and supporting institutions. Therefore the technological development of solar technology which is low is a factor contributing to slow rate of adoption of the technology.

5.2.5 Supply Problem

The supply problem in the delivery system to the potential customs have been considered as a factor contributing to the low rate of adoption of the technology since Katulani sub-location is situated far way from the growth centres where people can obtain vital awareness information and equipments.

5.2.6 Lack of supporting institution including Governments

Lack of supporting institutions such as marketing and credit organization including government are not available in area under study. Supporting institutions play a very important role in promoting acceptance of a product, technology or an idea. These institution are lacking in Katulani sub-location and this explains why there is low rate of adoption of solar technology.

5.2.7 Non-availability of after sales services

Lack of competent personnel and non-availability of after sales services have been included as factor responsible for the slow rate of adoption of solar technology in Katulani sub-location. The adoption of innovation depends on some combination of well-established interpersonal ties and habitual exposure to mass communication. Once the individual is aware of the innovation his/her interest may be aroused and search for more information. Ronger clarified the work of Ryan and Gross by identifying five major steps in the adoption process. These stages are awareness, interest, evaluation trial and finally adoption. In the first stage, the potential adoptor learns of the existence of the innovations. It is at this point that the mass media as well as interpersonal contacts, bring the relevant information to the attention of the potential user.

Rongers also addressed the question of whether awareness of an innovation is created on random basis. The answer is that this seems likely. Thus awareness is undoubtedly related to some type of need that would potentially be satisfied by the new product or technology. The diffusion problem which lead to widespread acceptance of innovation depends on personality factors which vary according to individual. Thus there are early adopters who respond more quickly to radical concepts. The early majority help legitimise the process. The late majority consolidate the process and the laggards are the least to accept. In view of the diffusion process, the mass media may best been reserved for motivation, evaluation, information, reinforcement and influence.

5.3 Recommendations

Based on the findings of the study which has established that the adoption of solar technology is not widespread, recommendation have been made to encourage widespread adoption of the technology. The following recommendation are directed towards all the stake holders in production and use of solar technology.

5.3.1 Reduction of cost of solar panels

The social economic status of the people dictate what to purchase and what not to purchase. Since it was established that many people cannot afford to buy the panel and the necessary accessories, because it is expensive for them, then it is important that solar manufacturer came up with panels which are not only cost effective but also reliable. In this regard, the government can cheap in and subsidise the production of panels. Also the government can give tax holiday to solar manufacturers. The economic sense suggests that when the supply is increased the price will go down and therefore widespread use of solar technology. The use of the technology will be increased since the limitation on its use is the cost association with its acquisition and installation see appendix B

5.3.2 Training

Training requires the development of a plan for various categories of personnel at various levels. The content and methodology and its duration should be spelt out including the resources needed. As it was noted in the findings, there are no qualified people to install, the solar technology, therefore it is necessary to train people in this category since the number of qualified personnel is either too small or its not feasible. In an effort to increase the number of qualified personnel in the area, a plan for study at national and regional level should be developed. This kind of training should be supported by the government through the learning institutions. At the same time the government should support it by infusing the teaching of solar technology in the school curriculum, where necessary and where applicable. The manufacturer of the solar panels should sponsor training in this area so as to increase the number of skilled personnel in the area. It was noted in the Literature review that people are unlikely to adopt any technology if they lack the necessary skills even where the technology is beneficial to themselves. Curriculum programmes devised to form part of the curriculum work of an educational institution either as

complete item (e.g. in social studies) or as examples to be used in such areas as scientific and mathematical studies.

5.3.3 Increase awareness campaigns

It is hereby recommended that mass media are at their best in creating awareness, providing stimulation and motivation and giving access to information. They can also be employed to contact field workers to pass on necessary information and to keep communication channels open between headquarters bureau and extension workers as promotion campaign progresses. However, it should be noted at this specific stage of evaluation, trial and adoption, interpersonal, face-to-face communication counts for much more and the inability of mass media to maintain two-way dialogue with regular feed back restricts their utility. But at the same time, the mass media can give most productive results when they are used in conjunction with an existing or specially created, network of interpersonal channels, where their messages are designed to acknowledge, and if possible capitalize upon an existing social and cultural framework.

5.3.4 Use of folk media

In the process of creating awareness fork media is hereby highly recommended because of the role it plays in process of development and social change. Folk media are personal forms of entertainment and communication. This is important because behavioural changes are most easily brought about by personal interaction. These forms of art are a part of the way of life of a community and provide acceptable means of bringing development issues into the community on its own terms. They are capable of reaching intimate social groups, thus making use of already established communication network in the target audience.

These forms of entertainment evolved as grass roots expression of values and lifestyles of the people, dealing with values as well as information. These features are significant for promoting adoption since it rapidly becomes apparent that sometime more than information is necessary to bring about behavioural changes involved in adoption and continuation practices. Another advantage of the folk media is that they attract people who might not attend an educational meeting with skills new content might be added to the old forms which are already familiar and dear to the people. Finally unlike mass media programmes produced for large and often diverse audiences, the folk forms can use familiar dialects for the most intimate and local

community. While they could reinforce relevant social change (solar adoption) that already occurring (or to be used) directly to introduce new ideas), folk forms should not be used for propoganda. To implement a communication strategy in which folk media are involved in an acceptable manner, it is necessary to obtain certain information about society and the traditional media. Understanding of values, attitudes and customs of the society is crucial, as knowledge of the role traditional media play in culture. Being close to people at the local level, these channels are potentially useful in service of social concern as determined by local, provincial or natural authorities themselves. They are, however, abundantly present in areas where mass media technology has not been fully or effectively developed to capture sustained interest at local, provincial or national levels.

Most of the awareness of solar technology is done through the use of radio/TV and newspapers advertisements. These however, do not have appeal to rural population. It's therefore against this background that fork media is recommend in the area under study. It should be noted that folk or traditional media is community based and integrated in the peoples' belief and value system. This is because they enjoy high credibility, the use of community radio such as FM Musyi, Kameme, Inooro and Ramogi should be used along the folk media.

5.3.4 Research

Research is necessary to establish the baseline data on knowledge, attitude, practice and belief of the audience for developing the necessary communication strategies whose impact over a period of time could be evaluated against the base line already established. Such research need not always be of long duration or very complex. The baseline survey could be established on the basis of the analysis of existing researches and/or small-scale survey in areas or communities which are focus of innovation. The research should aim at establishing the actual needs of the people under focus. This research is very important because if the needs of the people can be met by some other means more conveniently then, therefore any effort directed towards promoting the alternative product will not be successful. The finding of such research are useful in sense that they can help in formulating communication strategies aimed at changing people's attitudes, beliefs and practices.

5.3.5 Credit facilities

The role of supporting institutions such as marketing and credit organization need not be over emphasized in the effort towards promoting adoption of solar technology. The availability of credit organization empower the potential customer to purchase the product over a long period of time. In their absence people will not be able to purchase the product. In case of the solar technology the absence of the credit organization was cited as one of the factor contributing to slow rate of adoption of solar technology in Katulani sub-location. Again, the area under study is rural one, situated far away from growth centres such that there is no government intervention in terms of government incentives. Therefore it's hereby recommended that government intervene to provide all the necessary incentives to encourage people to purchase the solar panels.

5.3.6 Demonstration of solar technology

People believe in seeing and as Rogers notes, people will adopt a technology, idea or practices if the results are feasible to the people. Therefore demonstration increases the level of information about the innovation which the potential adopter of the technology seeks. Demonstrations are vital channels through which information, education and communication are used in an integrated fashion to promote awareness and understanding of issues concerning solar technology. Information includes technical and statistical information that is used to create awareness among governments, non-governmental organization and communities. Demonstrations are therefore recommended because they create awareness which brings facts and issue to the attention of an audience. The primary aim being to provide materials to stimulate discussions.

Education draws upon communication because educators must communicate with learners if they have to be effective teachers. Demonstrations are recommended because they are effective in changing people attitude, and acquisition of knowledge and skills. The aim of education is to foster genuine understanding of solar technology through demonstration over along time.

Through demonstration, communication is enhanced, which in turn contributes to enhanced knowledge about solar technology issues, change attitude and bring about a voluntary change in behaviour. Therefore the solar manufacturer can chose a particular home in a village

and install solar so that this home can act as a demonstration whose results are visible to the members of that village. This can increase the adoption of the solar technology.

5.3.7 Offer after-sales services

The seller of solar technology is recommended to offer after sales services. This is important because after sale service accords the adopter an opportunity to ask pertinent question. It also enables them to receive solution to their problem associated with the solar technology. The explanations they offer during the after sales services increase the information at the customer's disposal and possibility of continuous adoption.

5.3.8 Encourage women participation

As women constitute a majority of the poorest people and women relationship with their environment is special we need to involve them in adoption process. This is so because women are the main natural resources users and managers, being food produces and gatherers of fuel. Since women are very important in the rural economy it's recommended that for successful widespread, adoption of solar technology women must be involved. Thus with their traditional knowledge and resource management skills, it is possible to see women as key agents of a successful widespread adoption of solar technology. Women and children are often victims of power failure because they spend most of their times in their homes and therefore there is every reason to involve them in the process of adoption of solar technology. The rural women are very instrumental in promoting community participation and reflection of public opinion, encouragement of dialogue between community and service providers and opening of channels of feedback.

5.3.8 Recommendation for further studies

Research is a pre requisite for a successful adoption of solar technology, since it acts as a guide to planning and for providing insights into the nature of the communities to be reached, their social-economic and cultural background, the level of their attitudes, knowledge, their needs and the ideas and perceptions of ways in which their needs could be met. Further research in the area is vital for it will provide the clues to solutions to meet the people's perceived needs.

Moreover, it is the baseline data provided by research that will help in evaluating the impact of a solar technology to the lives of people..

Considering the interdisciplinary and inter-sectorial nature of development communication, research can be useful in facilitating the integration of information education and communication activities to enhance successful adoption of solar technology.

Research further will help in developing sound communication strategies for increasing involvement participation and acceptance of solar technology, designing of appropriate content messages and material aimed at identification of the most effective ways to coordinate a mixed media presentation for the target audience. Therefore, it is on the basis of further research that messages and material development can begin for the audience and channels for dissemination determined.

All communication work in support of the adoption of solar technology should be based on audience research, pre-testing and post-testing activities and on feed forward and feedback. Further research could help determine the message sequencing strategies appropriate to social and economic milieu.

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Appendix A

Interview Guide/Questionnaire

Before going through the items in the interview schedule, I expressed my appreciation for the cooperation of the respondents. Prior to holding the interview, I had the opportunity of conveying the respondents the objectives of the study and the relevancy of the study to the Katulani sub-location community in general.

Development of Interview Schedule

Semi-structured interview guides was developed by the researcher and these were administered to solicit information from the respondent in relation to mechanisms that were instituted to acquire information about the product. Each of the data-collecting instruments was therefore, developed with the study objectives in mind, the interview guide was developed to gather the following information:

- Weather people make use of solar energy.
- How did the people get the information about the solar energy technology?
- The advantages of solar energy vs other forms energy.
- The uses to which they put the solar energy to.
- Source from where people get the product from (the solar panels and accessories)
- Are there change agent who may have adopted the solar energy.
- Are there technical people to assist in the installation of the solar panels and the necessary wiring?
- Do people have the capacity to adopt to the technology given their level of income?

The items of interview schedule and questionnaire were as follows:

Personal Information

1. Sex: _____
2. Age: _____
3. Education: _____
4. Occupation: _____
5. Do you make use of solar energy/electricity?

   Yes ☐ No ☐
6. If your answer to question 5 is yes, tick the uses to which you put solar energy.

   (i) Lighting ☐
   (ii) Water heating ☐
   (iii) Powering television/radio ☐
   (iv) Water pumping
   (v) State any other (s) _____

7. If you use solar energy, from where did you get the information about it. (Tick the source/sources).

   (a) Neighbours ☐
   (b) Solar energy personal ☐
   (c) Newspaper advertisements ☐
   (d) Radio advertising ☐
   (e) Television advertising ☐
   (f) Relatives/friends ☐
   (g) Personal enquiries/research ☐
   (h) Other sources _____
8. If you do not use solar energy/electricity, what makes you not use it?

   Reasons: _____
   _____
   _____

9. In your opinion which source of energy is more convenient to use in a rural setting: paraffin, gas, petrol/diesel, solar energy or electricity? (Tick)

☐ ☐ ☐ ☐

10. Do you use solar energy for any of the following: Tick yes or no.

Lighting Yes ☐ No ☐

Radio Yes ☐ No ☐

Television Yes ☐ No ☐

(b) If your answer is no to any of the uses in question 10 (a), briefly state why you don't use _____

11. If you have seen solar energy in use in your location, please explain briefly where the user: (NB: You may want to refer to question 7).

(a) Got the information about it from _____

(b) Obtained the equipment from _____

12. With reference to your answers to question 7 and question 11, is the information received from the indicated sources explicit and clear enough for a potential user or person interested in the use of solar energy/electricity. Yes ☐ No ☐

13. Which is your nearest town to your location from where you can obtain:

(a) information? _____

(b) Equipment _____

14. Are the boarding schools around your home using solar energy/electricity

Yes ☐ No ☐

15. How many business premises in your local shopping centre use solar energy/electricity

1–5 6–10

16. (a) Have you ever seen the use of solar energy being demonstrated in your location?

Yes ☐ No ☐

(b) If yes, who did the demonstration (Tick as appropriate)

Salesmen ☐

Distributors ☐

17. In your opinion do you think the solar energy can solve your energy problems?

Yes ☐ No ☐

18. Would the solar energy be generally affordable to the average resident in your area?

Yes ☐ No ☐

19. (a) In your opinion do you think there are competent people to install solar energy in your sub-location?

Yes ☐ No ☐

(b) If yes, are they employed there by national solar energy providers or local providers? *(Tick one).* ☐

20. In your knowledge, or with the information available to you about advantages and disadvantages of solar energy compared to those of other sources of energy, do you think solar energy is more advantageous and therefore more competitive than other sources of energy?

Yes ☐ No ☐

Give your comment about solar energy utilization: _____

_____

_____

Thank you